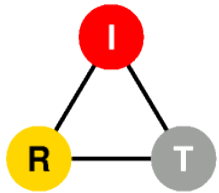


Application and Desktop Sharing

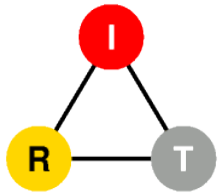
Omer Boyaci

November 1, 2007



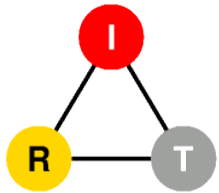
Overview

- **Introduction**
- Demo
- Architecture
- Challenges
- Features
- Conclusion



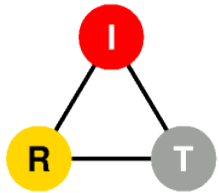
Application Sharing Models

- Application specific
 - + Efficient
 - Participants need application
 - Application has to be modified
- Generic
 - Inefficient (sometimes)
 - + Participants don't need application
 - + All applications are supported



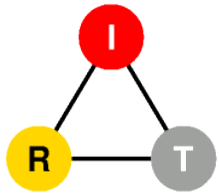
Application Sharing Models

- Application specific
 - + Efficient
 - Participants need application
 - Application has to be modified
- **Generic**
 - **Inefficient (sometimes)**
 - + **Participants don't need application**
 - + **All applications are supported**



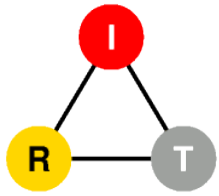
Overview

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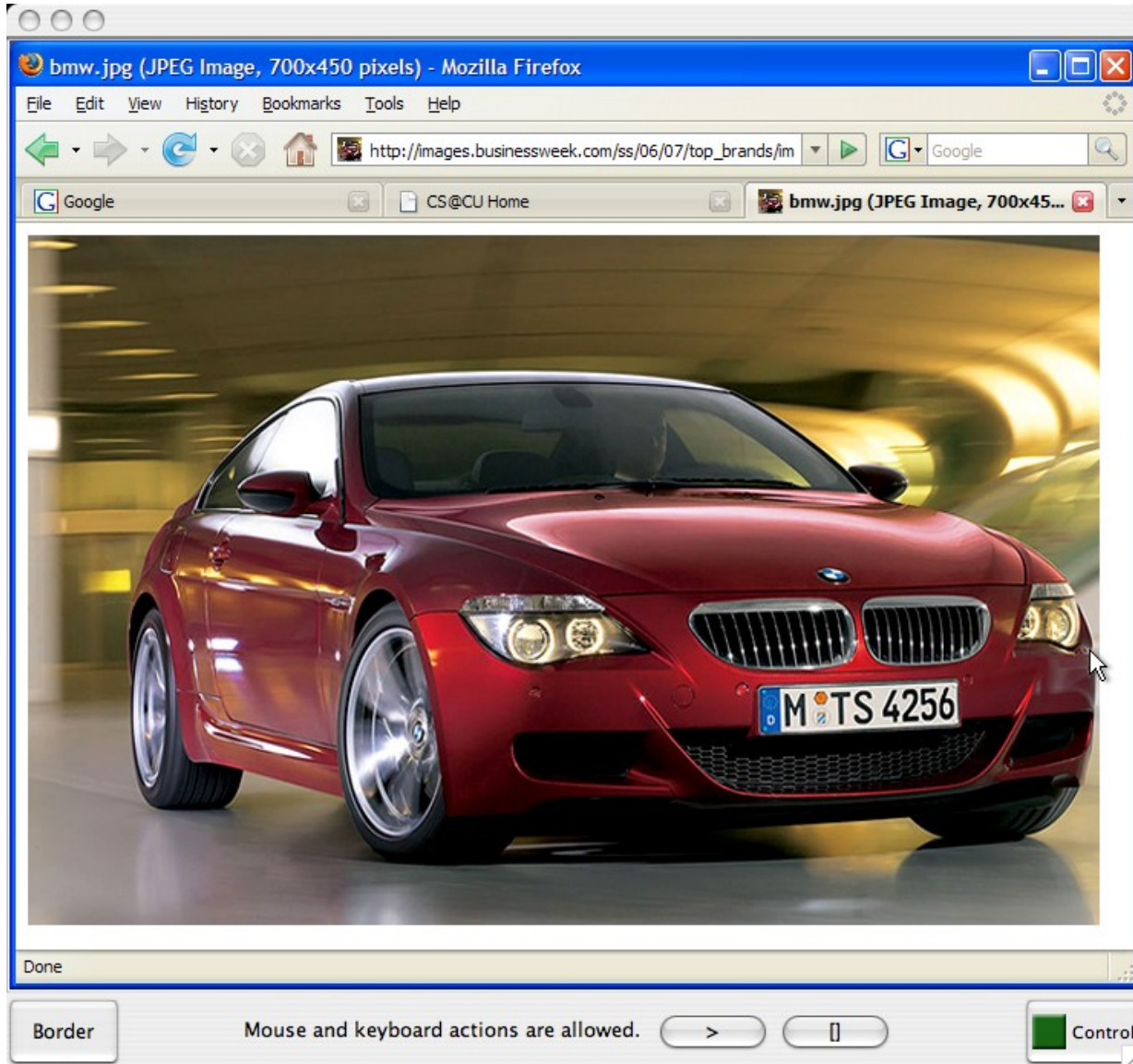


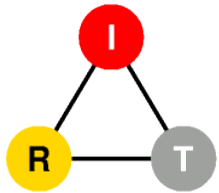
Application Sharing

- ◆ Sharing an application with multiple users
- ◆ There is only one copy of the application
- ◆ Participants do not need application itself
- ◆ Briefly, participants
 - ◆ receive screen updates
 - ◆ send keyboard and mouse events
- ◆ Desktop sharing is also supported.

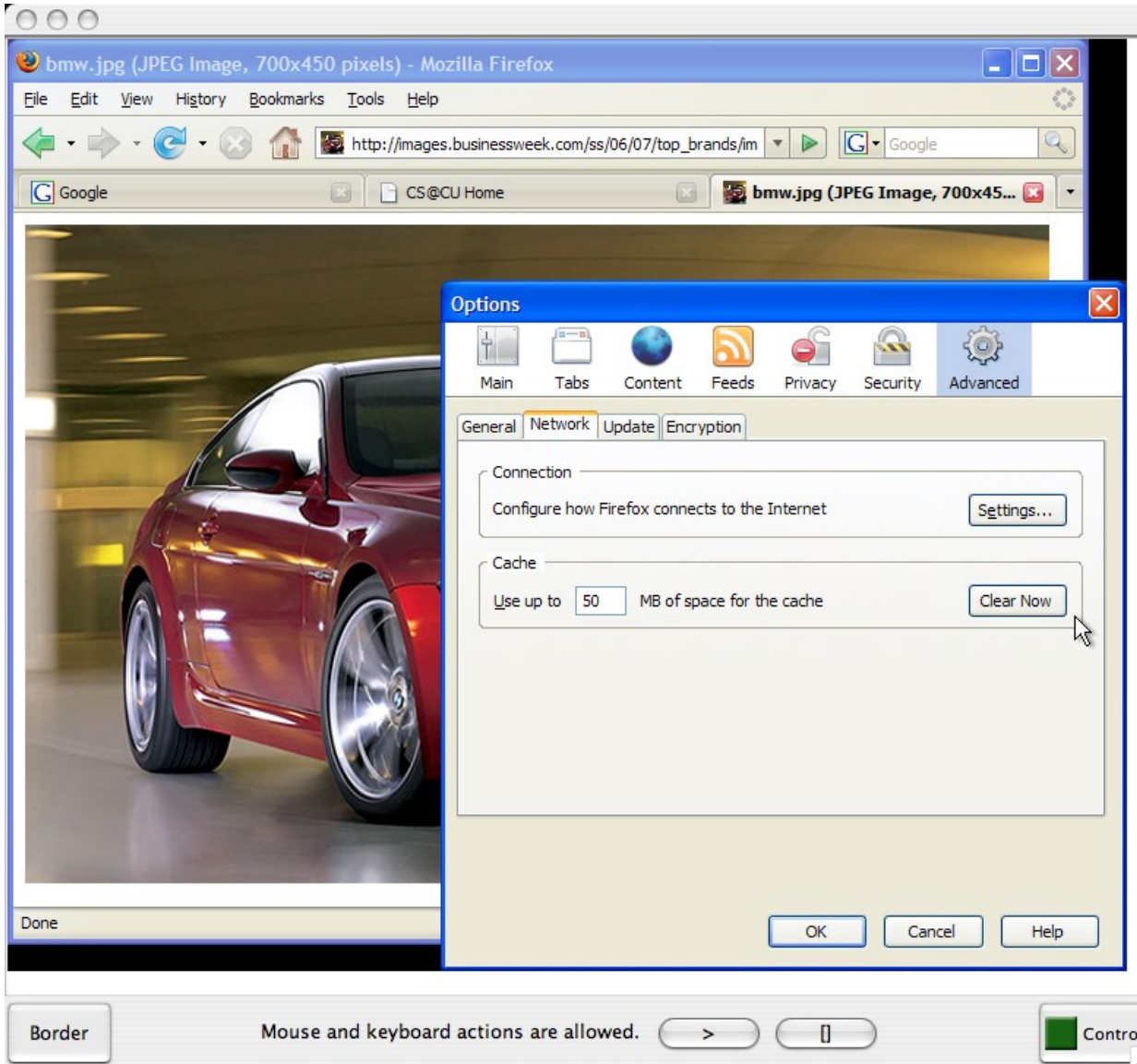


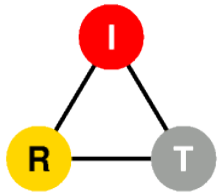
Screenshot



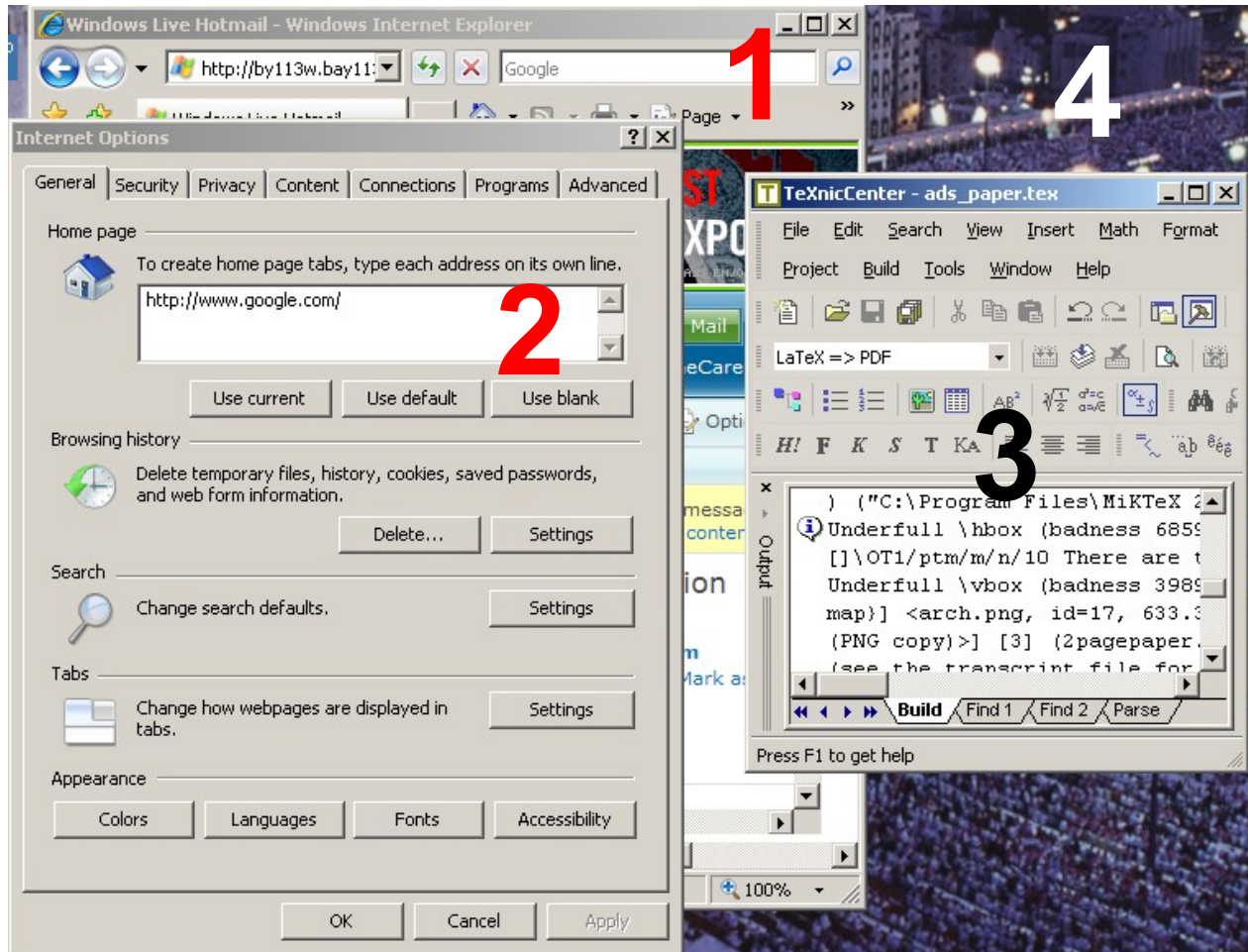


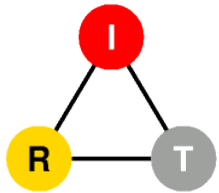
Screenshot (2)



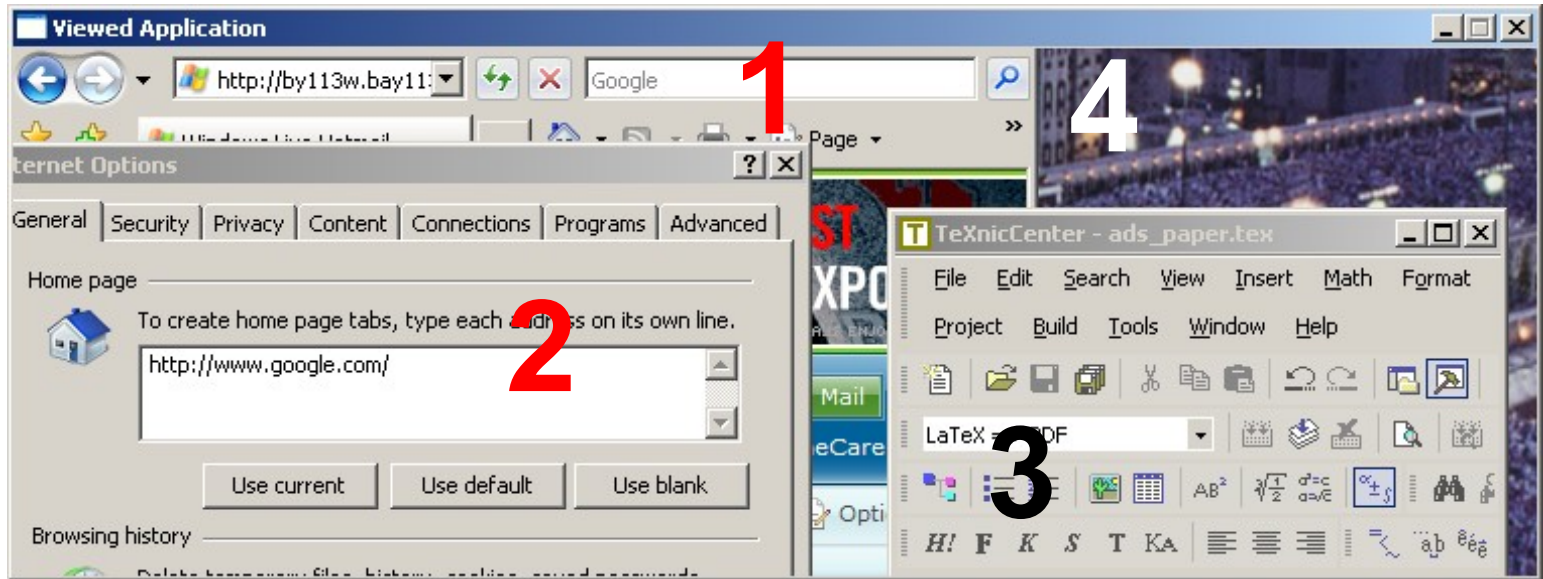


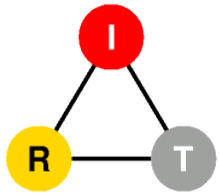
Screenshot (Overlapped Windows)



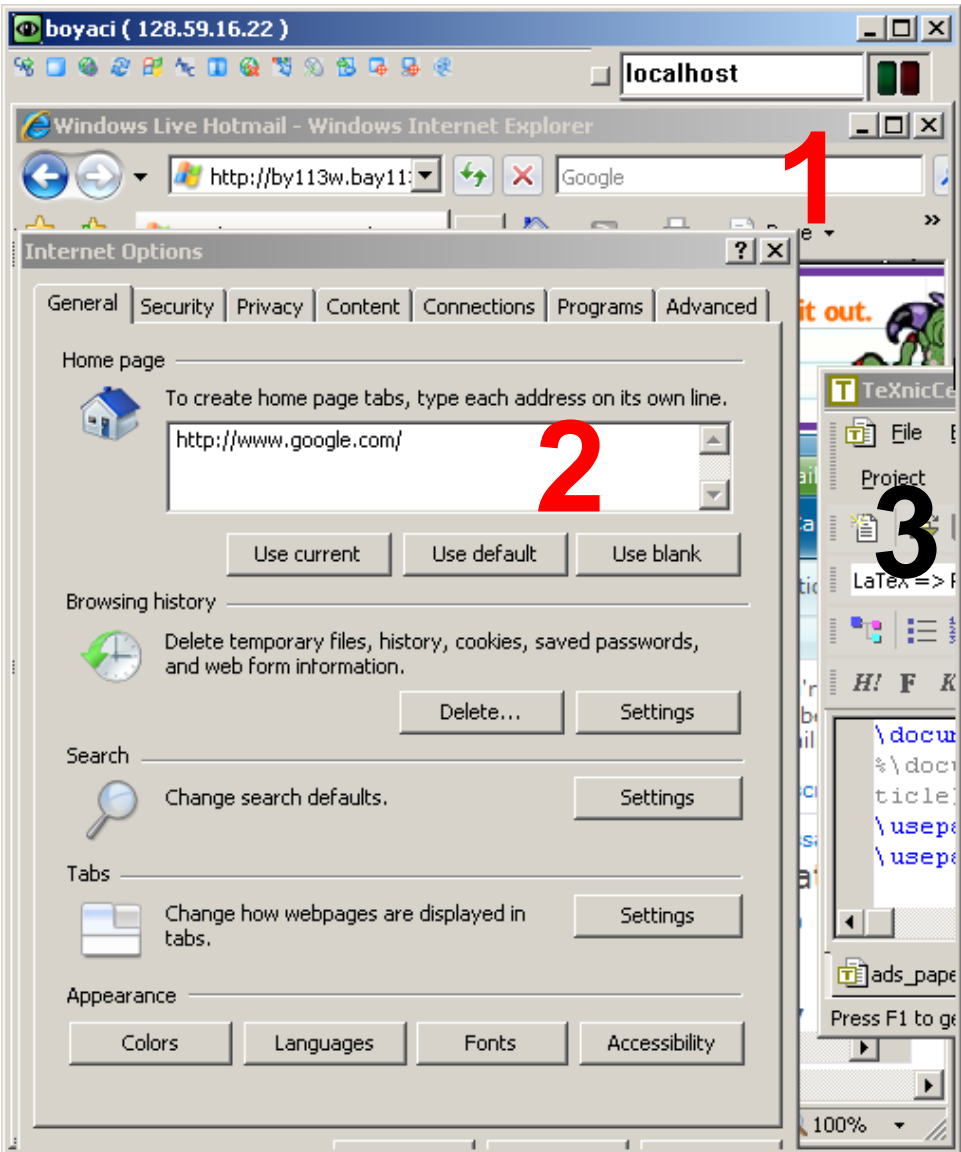


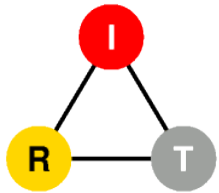
Screenshot (Multicast App. Tool)



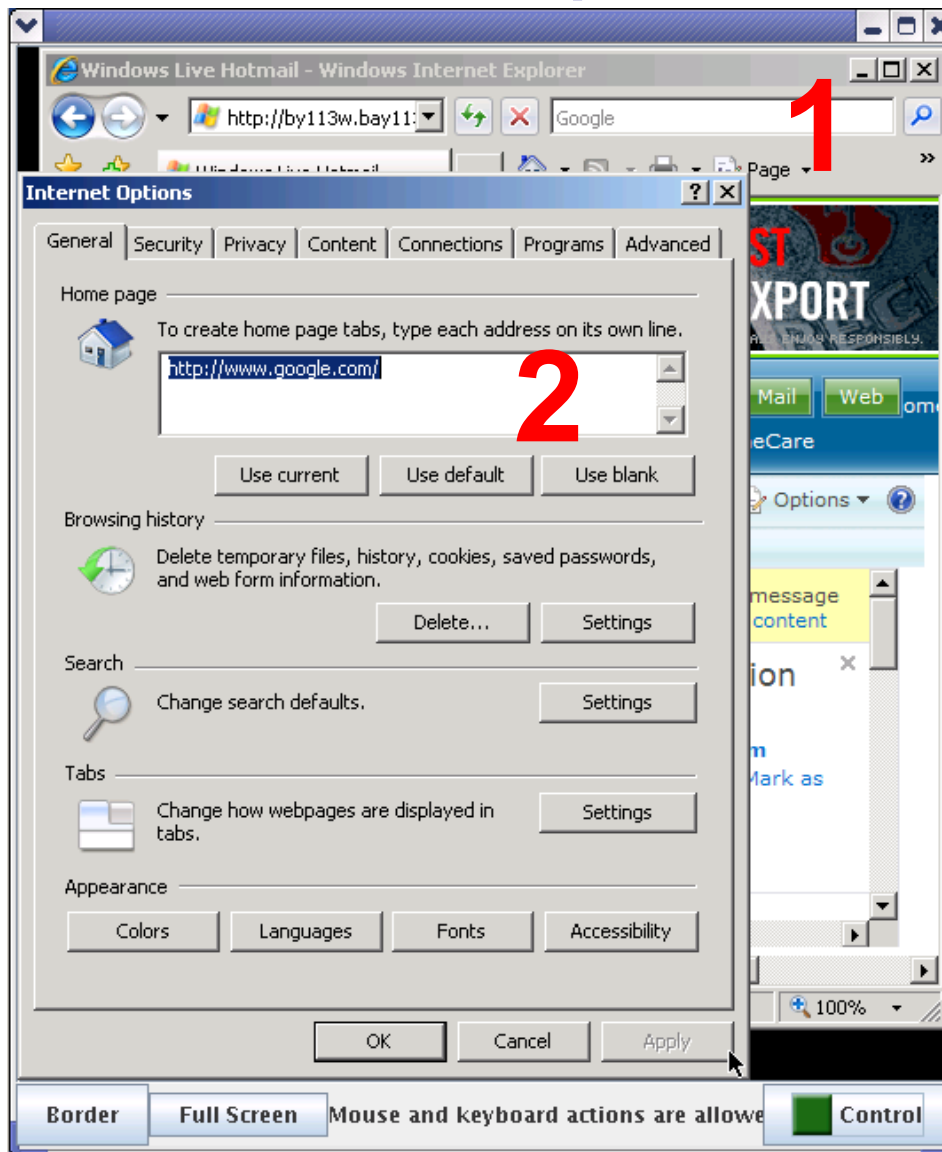


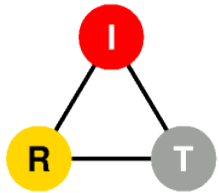
Screenshot (Ultra VNC)








Screenshot (App & Desk Sharing)

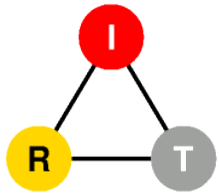




Supported Platforms/OS

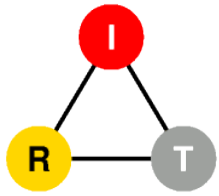
| | Server | Client* |
|--|--------|---------|
| Windows  | + | + |
| *nix  | -+ | + |
| Mac OS X  | - | + |

*Client is Java based.



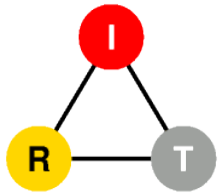
Overview

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- Architecture
- Challenges
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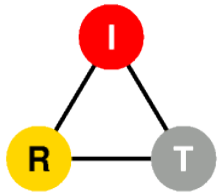
Demo

Demo



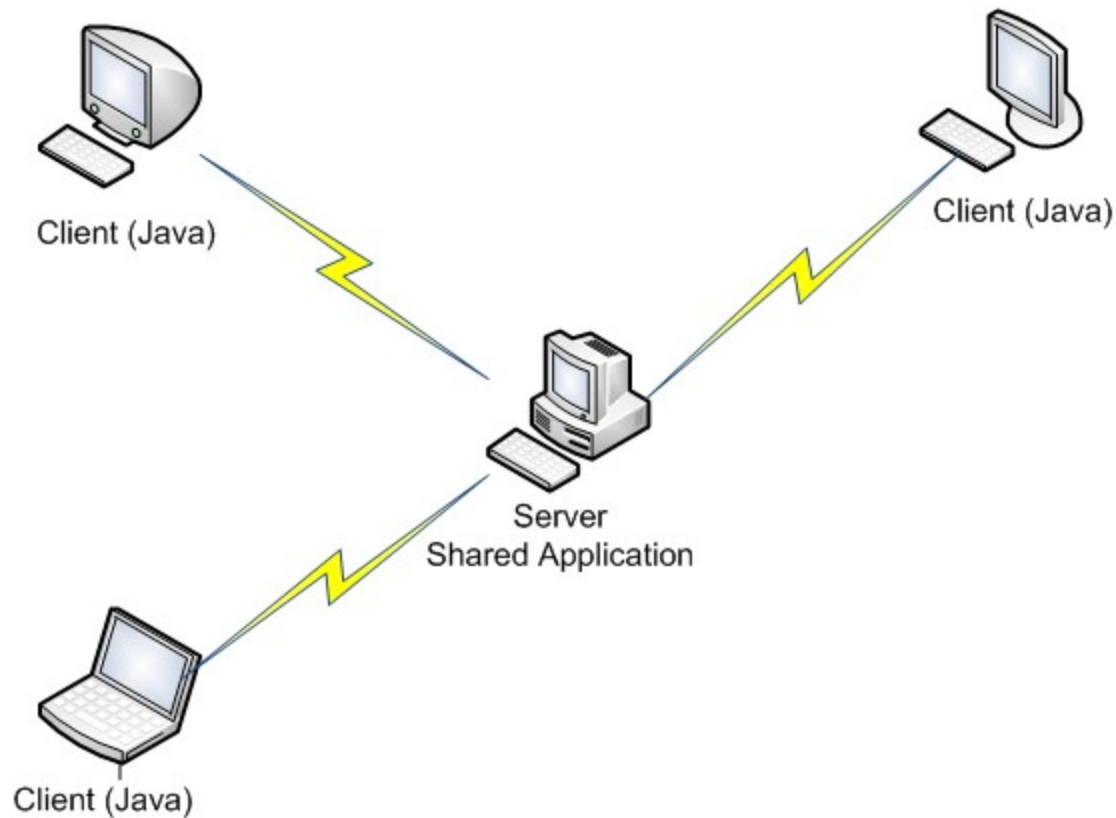
Overview

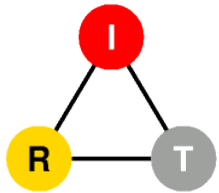
- Introduction
- Demo
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System Architecture

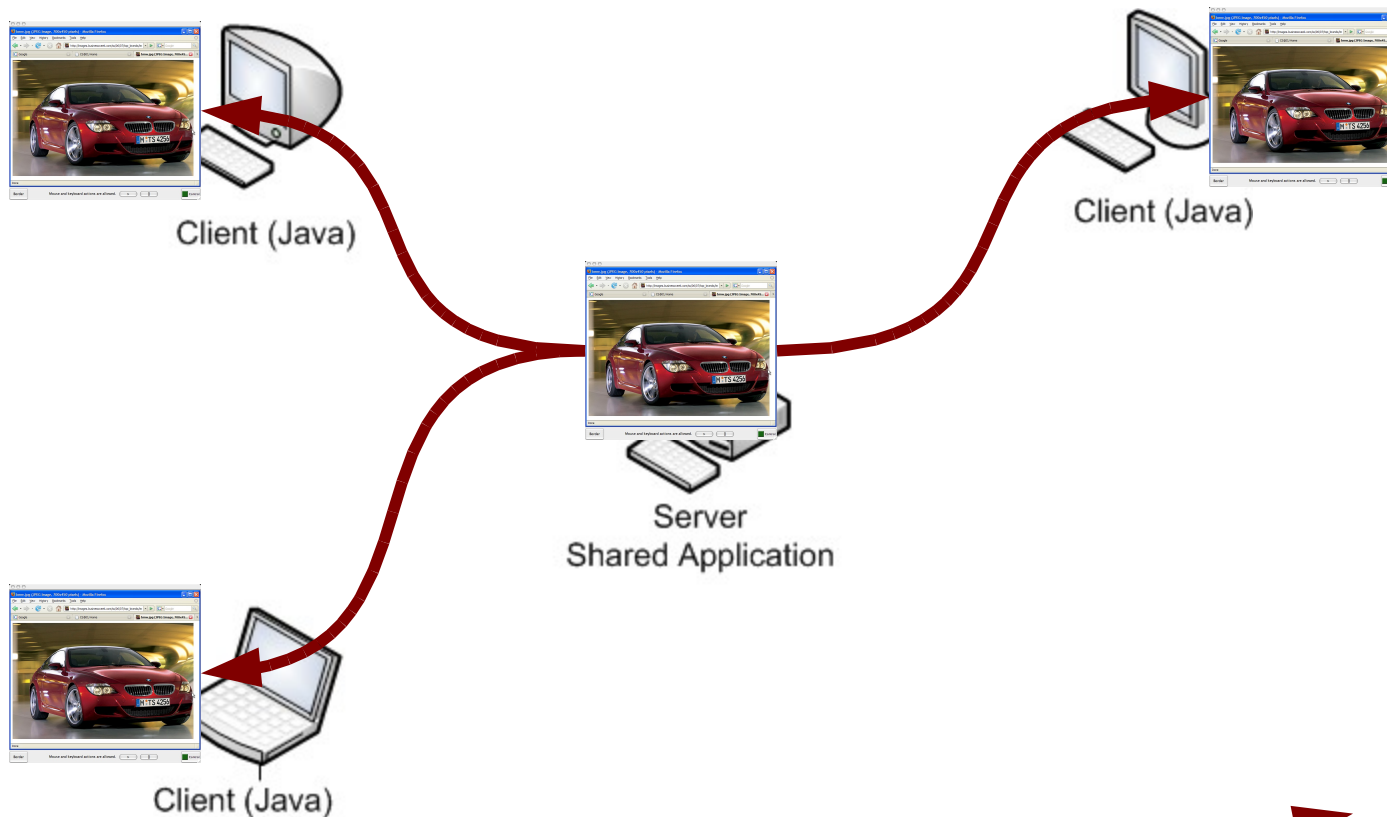
- Client/Server Software Architecture



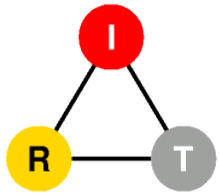


System Architecture

- Client/Server Software Architecture

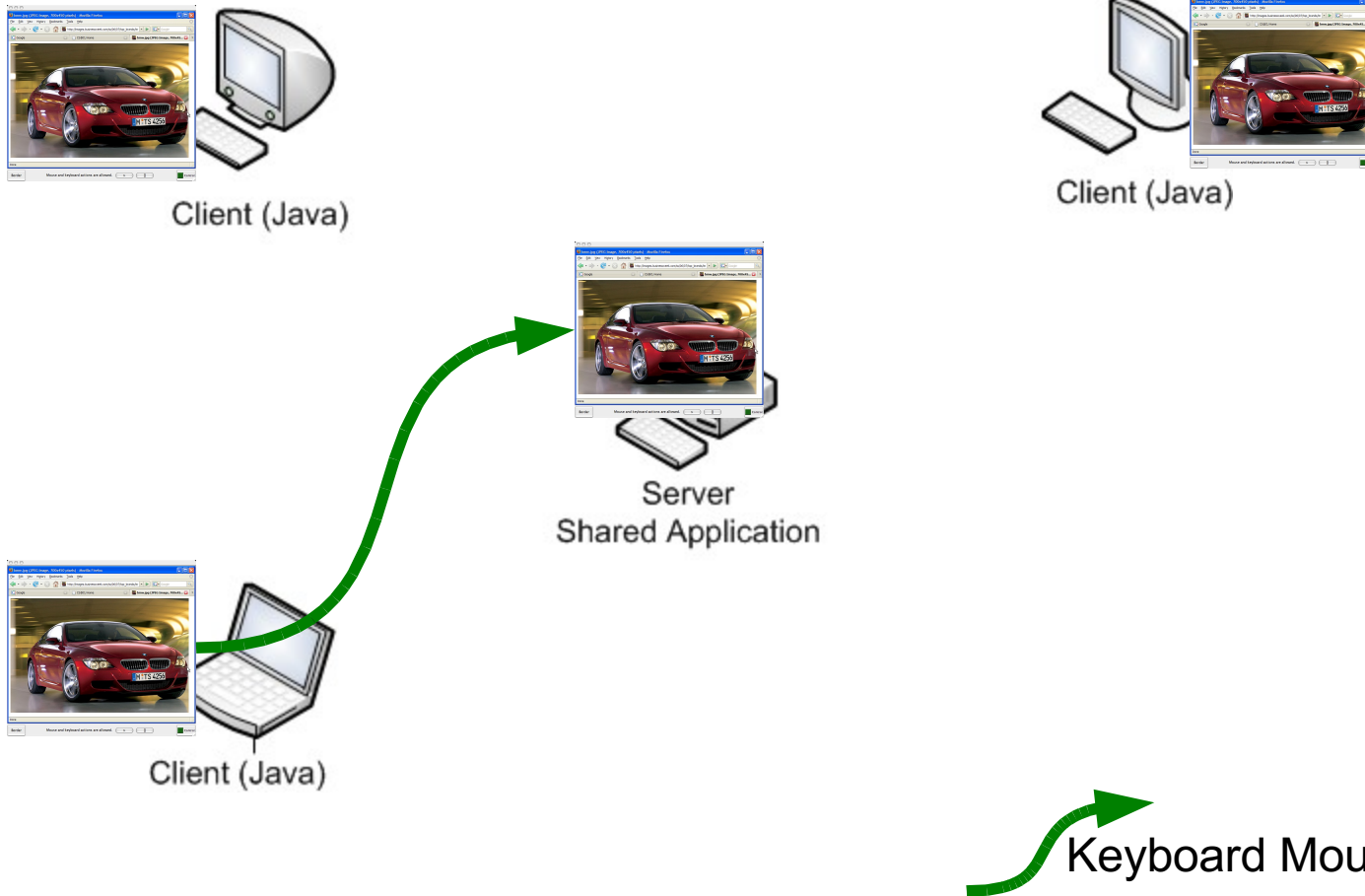


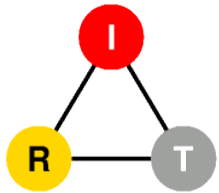
 Screen Updates



System Architecture

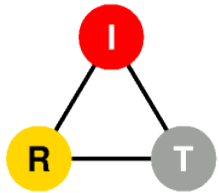
- Client/Server Software Architecture





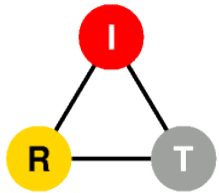
Client (Viewer) Architecture

- Client can
 - Connect to server
 - Wait for incoming connections
- Client supports
 - TCP
 - UDP (+Multicast)

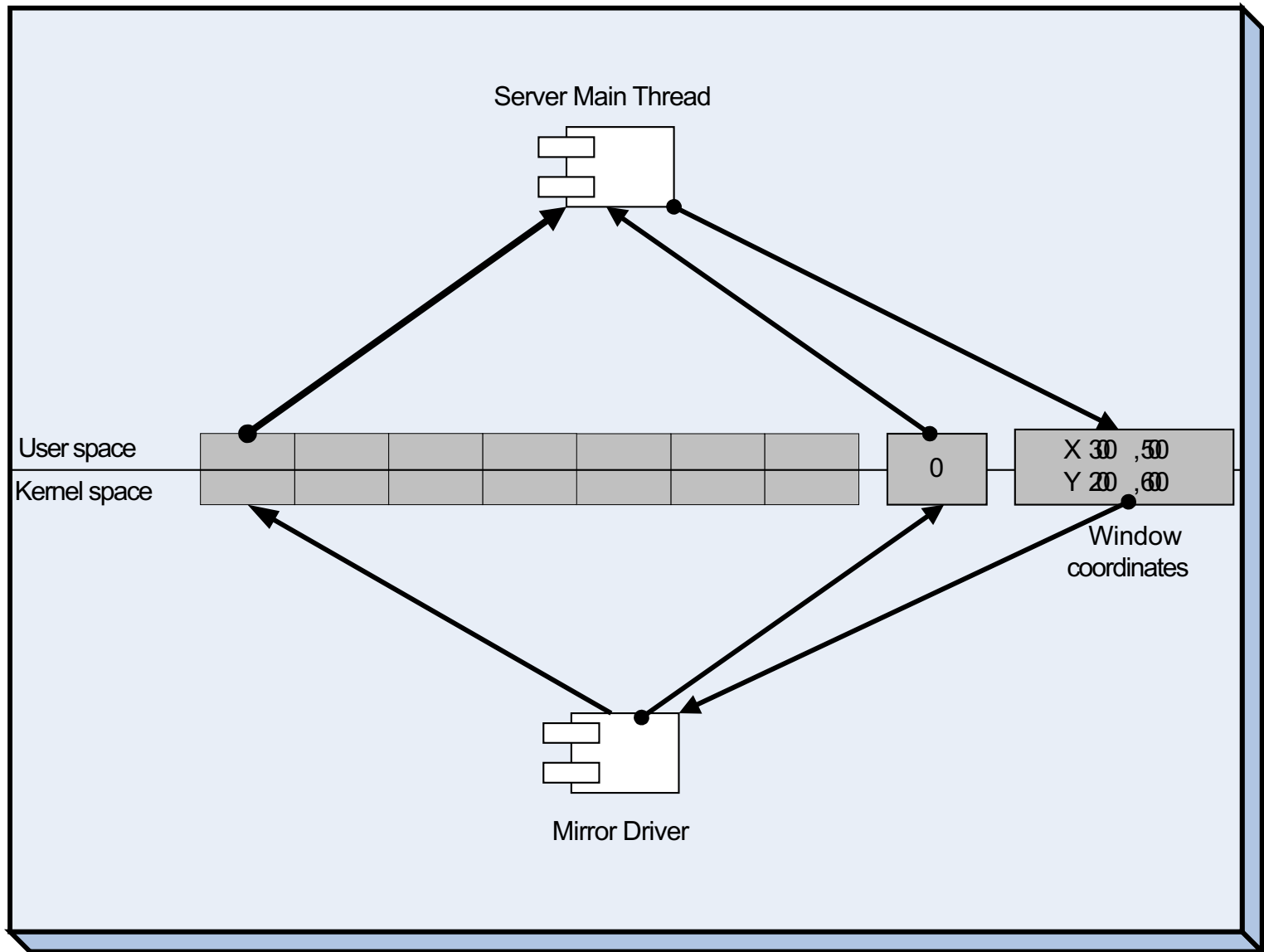


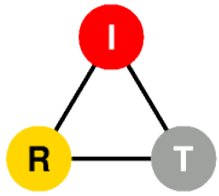
Client (Viewer) Architecture

- Client receives these commands
 - Open new window
 - Window size changed
 - Pixel update
 - Close window
- Client sends
 - BFCP (Binary Floor Control Protocol) commands
 - Keyboard and mouse events

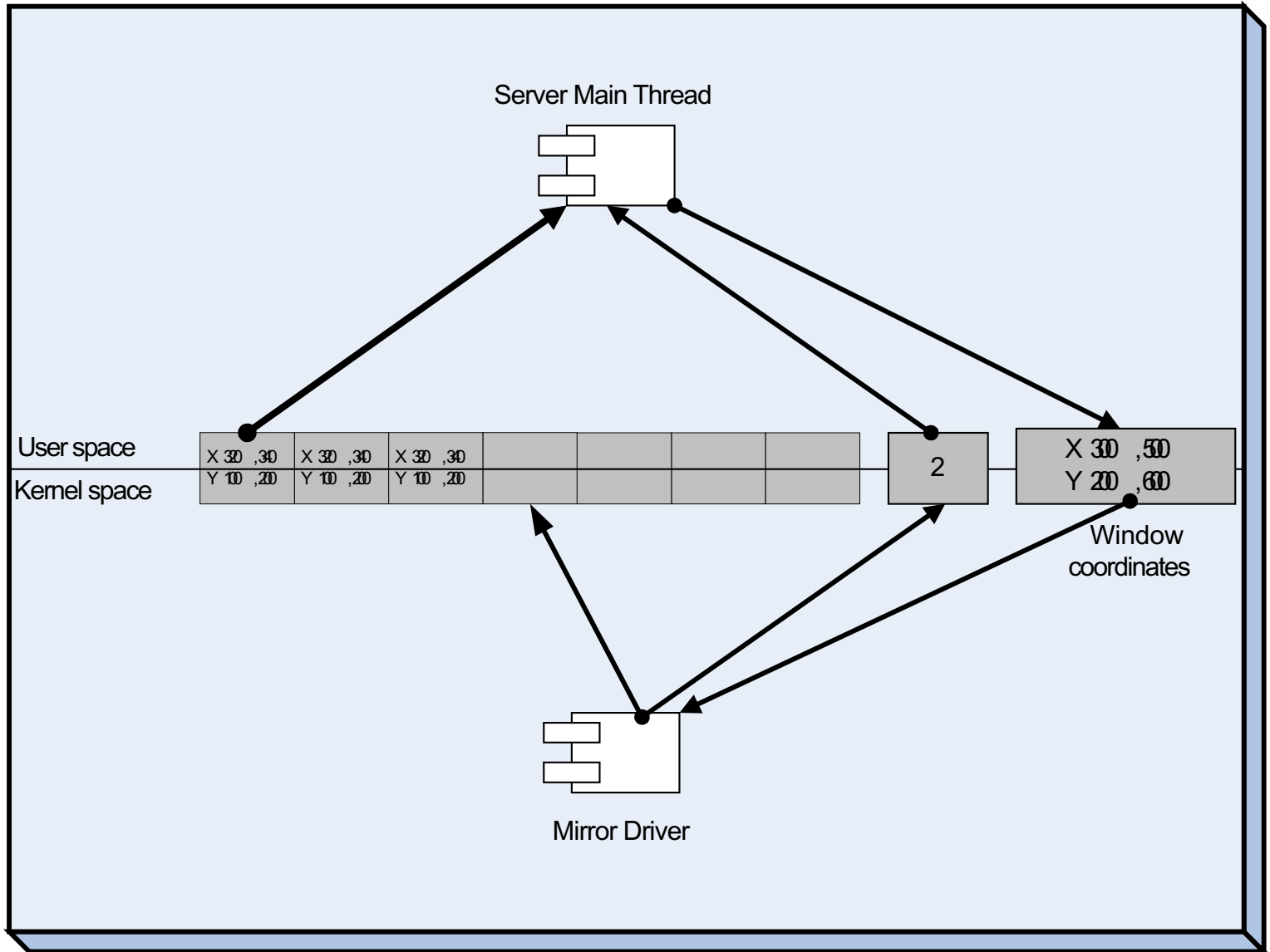


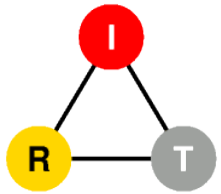
Windows Server Architecture



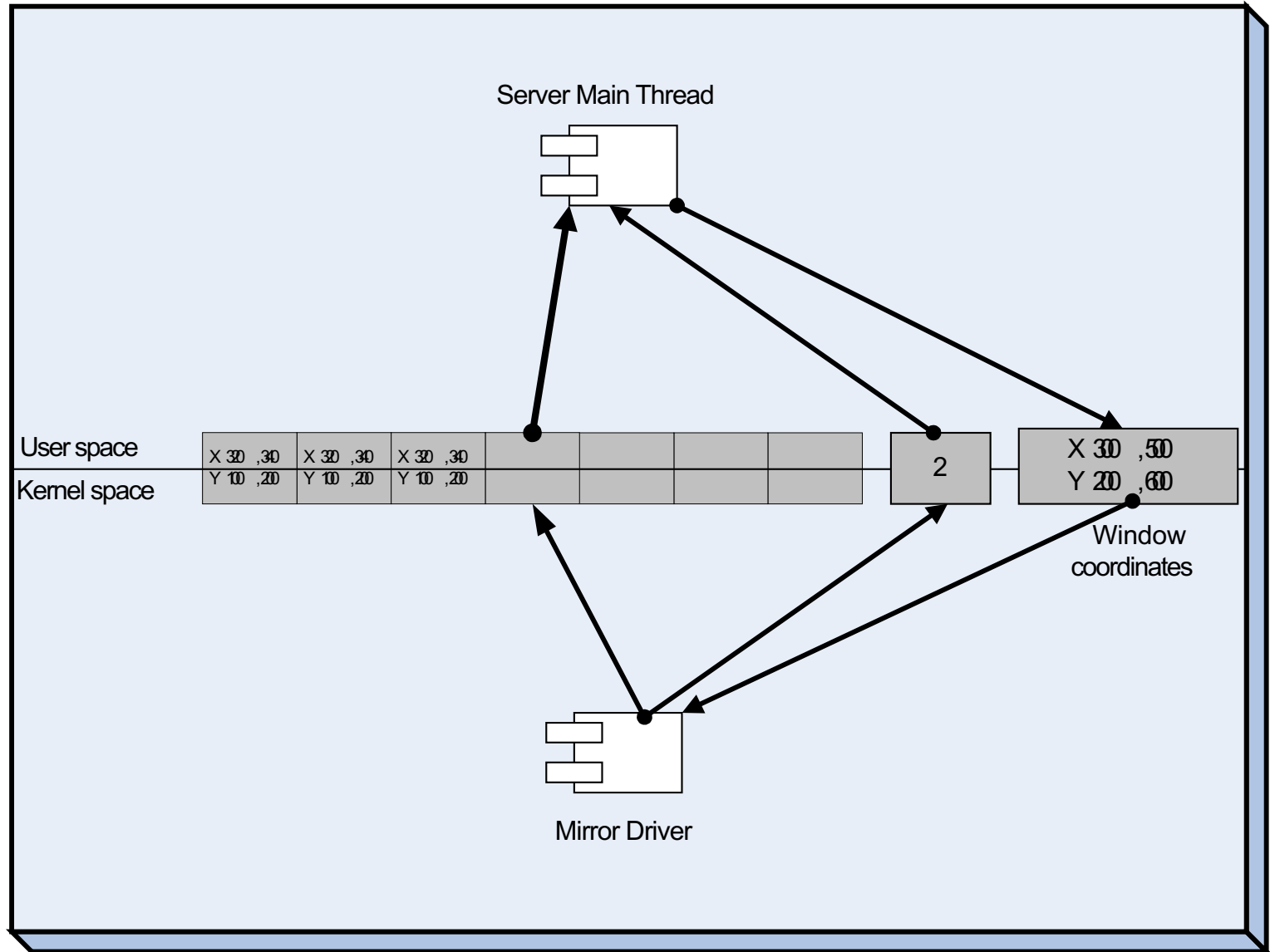


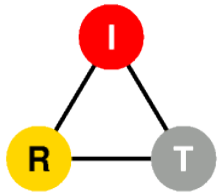
Windows Server Architecture



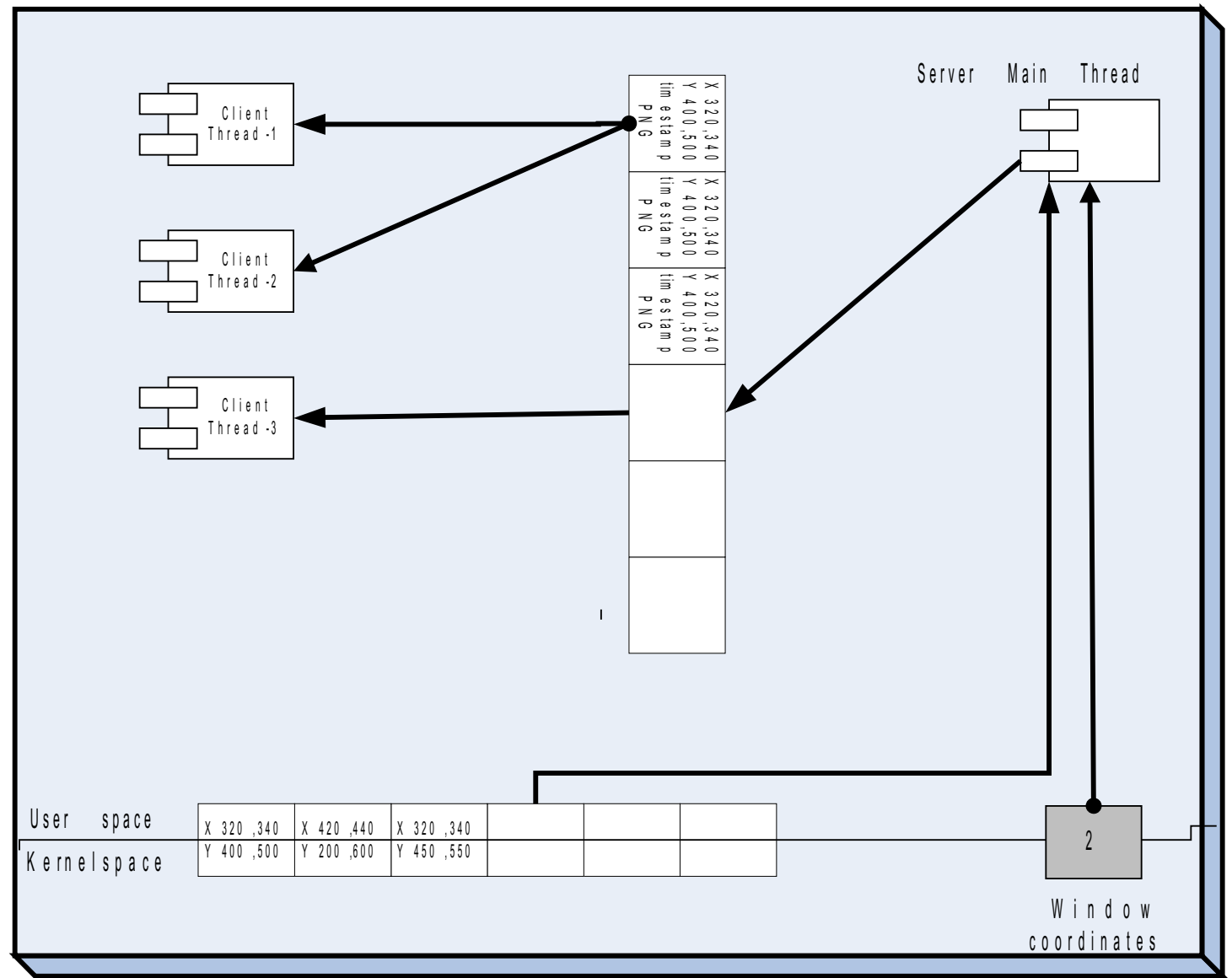


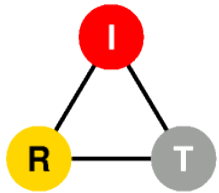
Windows Server Architecture





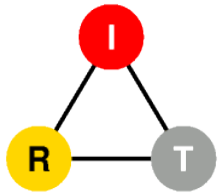
Windows Server Architecture





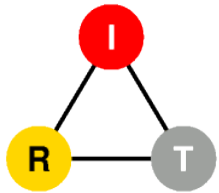
Overview

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Challenges

- Different client bandwidths/speeds
- Late Joiner
- The effects of packet loss
- Reliable multicast



Multimedia Support (Movies)

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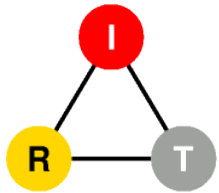
- [Red Sox Players R...](#)
09:05
- [宏基地振榮的 品牌 經營學](#)
05:14
- [Curious Probe](#)
04:37
theoniuses
- [Death At The Door...](#)
01:42

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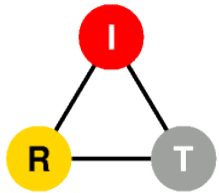
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Transferring data from sjl-v79.sjl.youtube.com...



Multimedia Support (Movies)

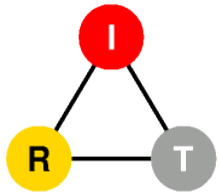
- Our system uses PNG to compress and transmit the region updates
- PNG is lossless and effective for computer generated images but ineffective for real world captures like pictures or movies
- JPG is more suitable for photographic images
- However, JPG is lossy and not effective for computer generated images (text, line, shapes,...)
- Our system should use both



Multimedia Support (Movies)

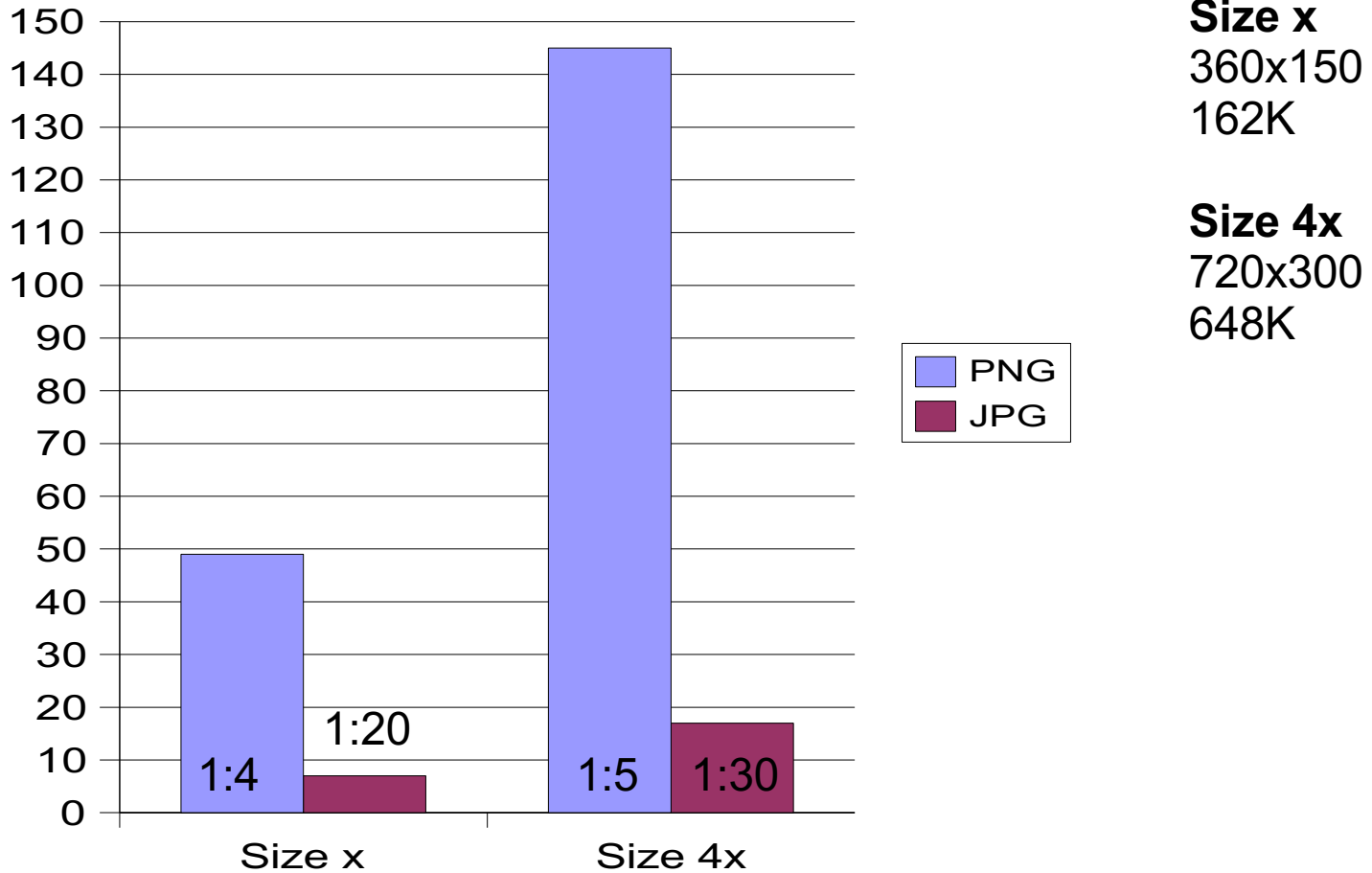
- Composite image comparing JPEG and PNG: notice artifacts in JPEG versus solid PNG background.

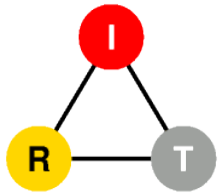




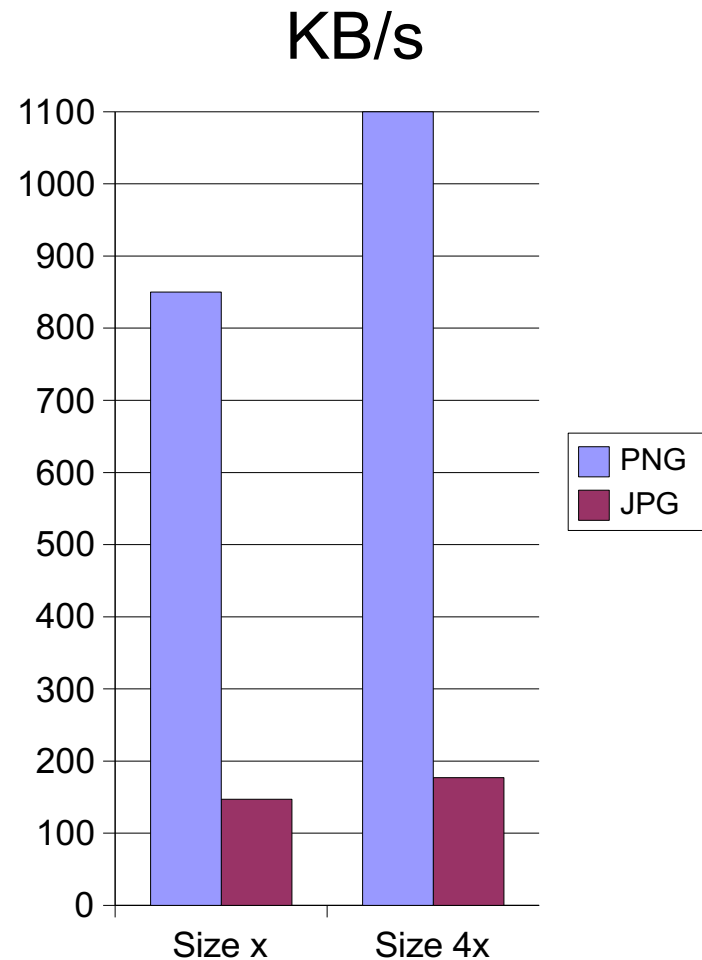
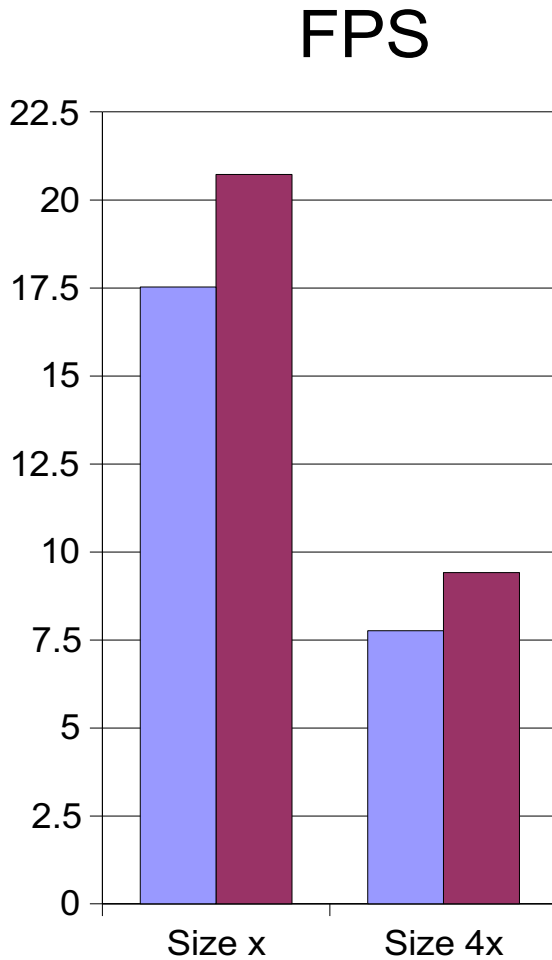
Multimedia Support (PNG vs JPG)

Image Size

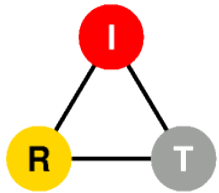




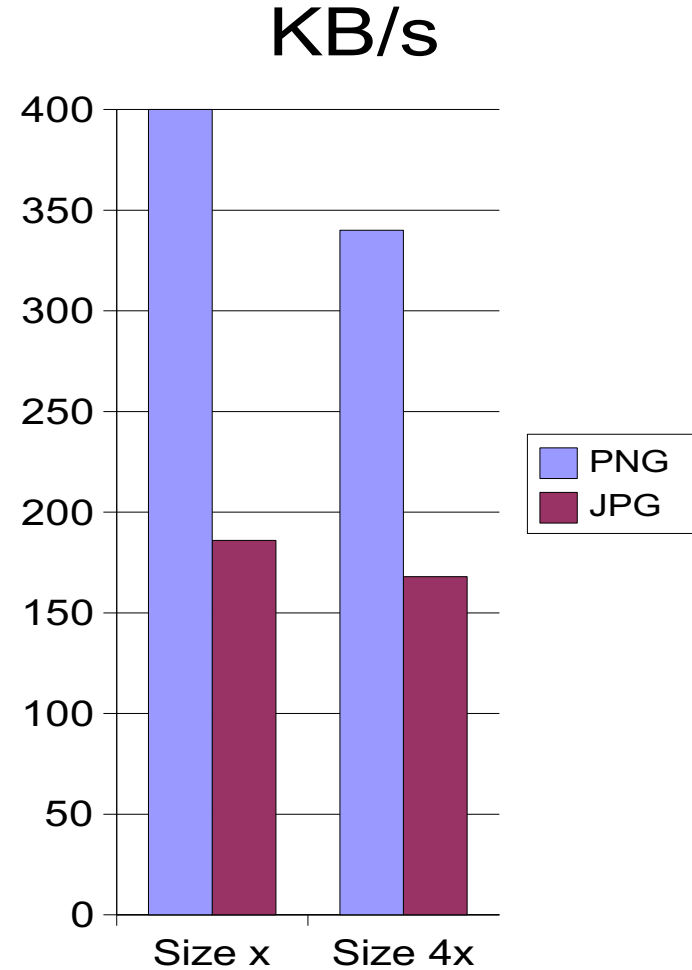
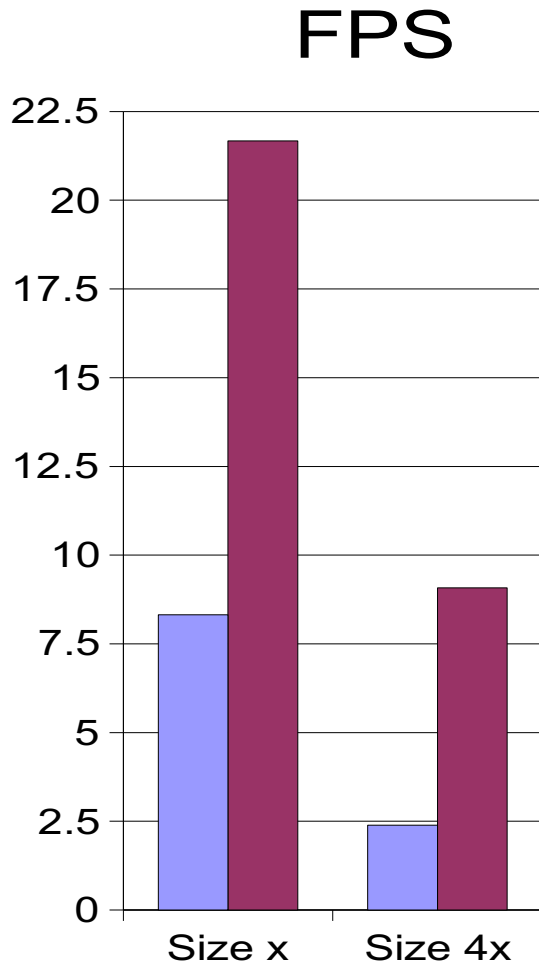
Multimedia Support (PNG vs JPG)



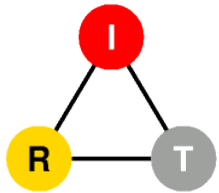
Ethernet (60Mb/s)



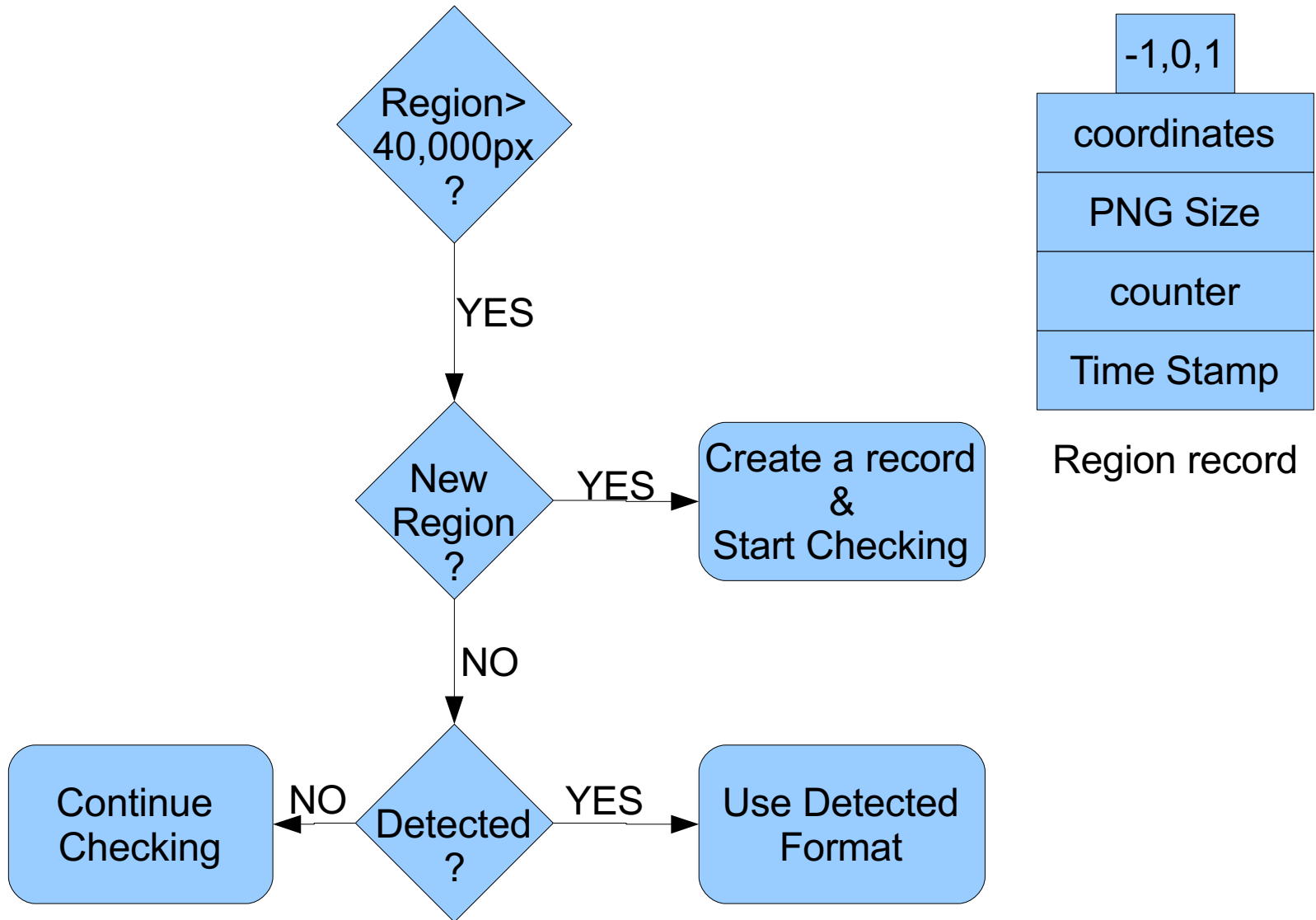
Multimedia Support (PNG vs JPG)

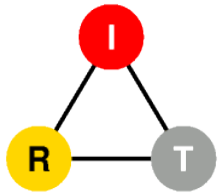


Wireless (4Mb/s)



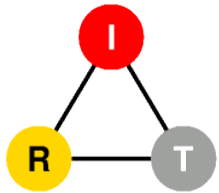
PNG/JPG Detection Algorithm





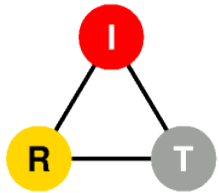
Sharing a Movie (Media Player)





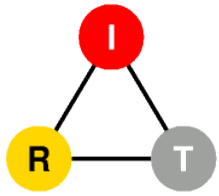
Sharing a Movie File

- Capturing from the Frame Buffer is expensive.
- Instead
 - Transcode the movie on the fly to JPGs
- FFmpeg (subproject of mplayer)
 - FFmpeg is a complete solution to record, convert and stream audio and video. It includes libavcodec, the leading audio/video codec library. FFmpeg is developed under Linux, but it can be compiled under most operating systems, including Windows.
- FFmpeg-Java (subproject of FMJ)
 - Java wrapper (JNA: Java Native Access)

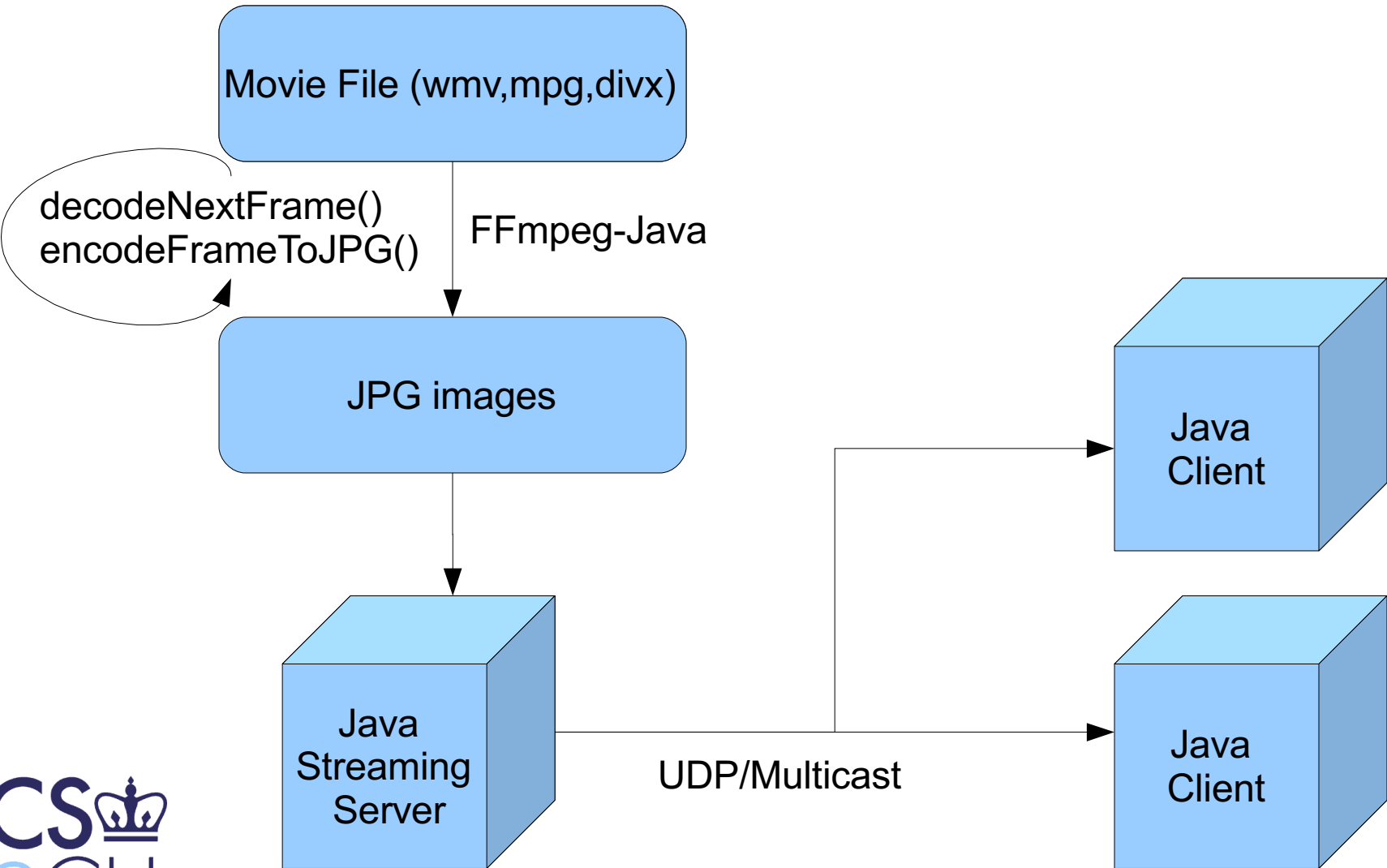


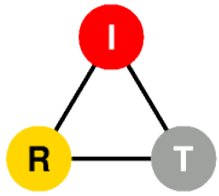
Sharing a Movie (Our Method)





Sharing a Movie File

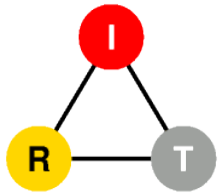




Demo

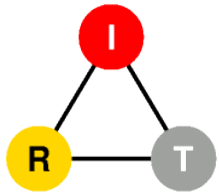
Demo

Multimedia Support



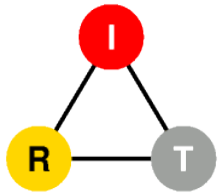
Challenges

- Different client bandwidths/speeds
- Late Joiner
- The effects of packet loss
- Reliable multicast



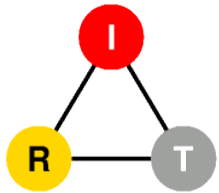
Different Client Bandwidths/Speeds

- Possible Solutions
 - Slowest one
 - Average speed
 - Fastest one



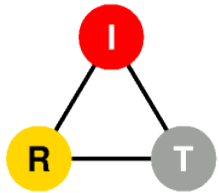
Different Client Bandwidths/Speeds

- Possible Solutions
 - Slowest one
 - Problem: Penalize everybody except the slowest
 - Average speed
 - Fastest one



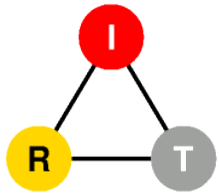
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 - Possible solution
 - Fastest one



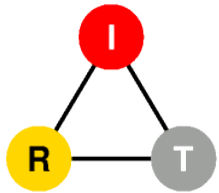
Different Client Bandwidths/Speeds

- Possible Solutions
 - Slowest one
 - Problem: Penalize everybody except the slowest
 - Average speed
 - Possible solution (Can we do better?)
 - Fastest one

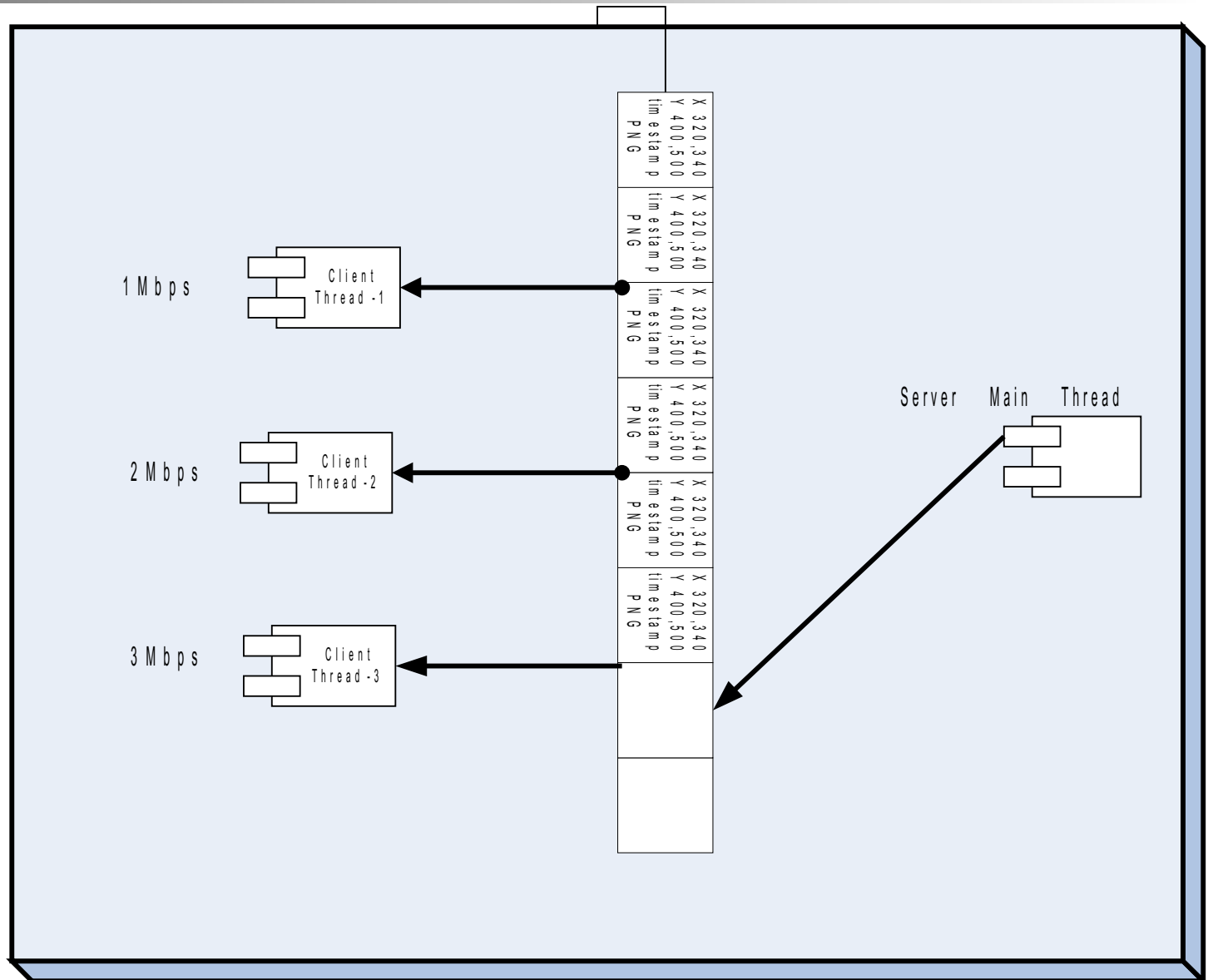


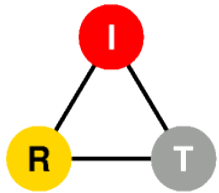
Different Client Bandwidths/Speeds

- Possible Solutions
 - Slowest one
 - Problem: Penalize everybody except the slowest
 - Average speed
 - Possible solution (Can we do better?)
 - Fastest one
 - The best solution
 - Client bandwidths are fully utilized



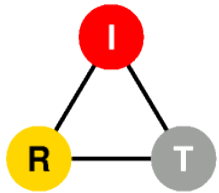
Different Client Bandwidths/Speeds





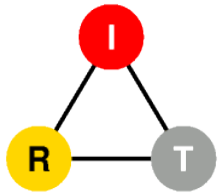
Challenges

- Different client bandwidths/speeds
- **Late Joiner**
- The effects of packet loss
- Reliable multicast



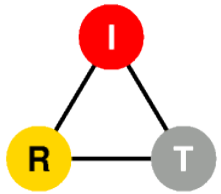
Late Joiner

- Force server to generate full screen update

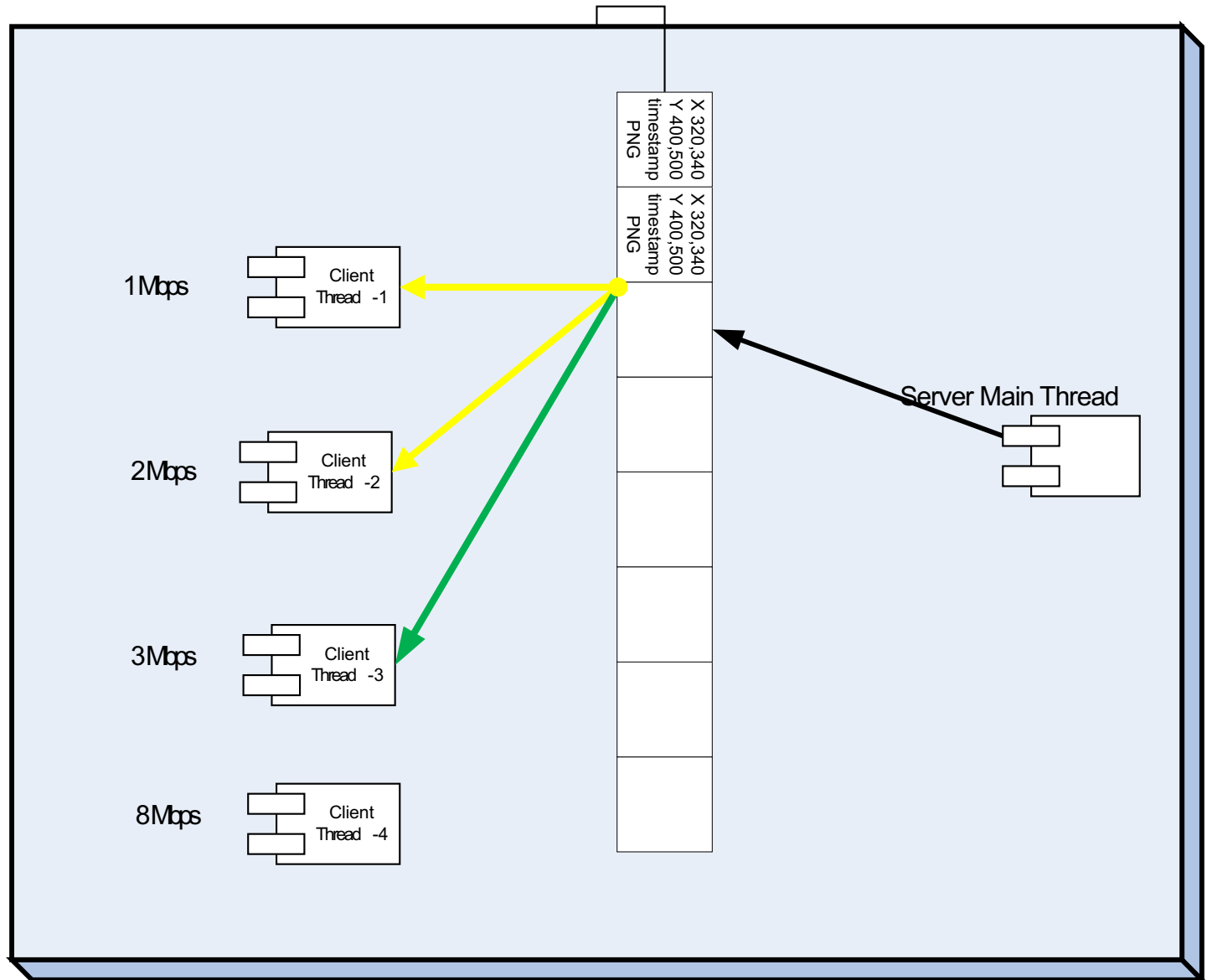


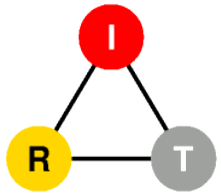
Late Joiner

- Force server to generate full screen update
 - Problems
 - Misbehaving clients can degrade performance
 - If Join/Leave rate is high, too much burden on server
 - Solution
 - Generate full screen updates if really necessary
 - Otherwise start the new client from last full screen update

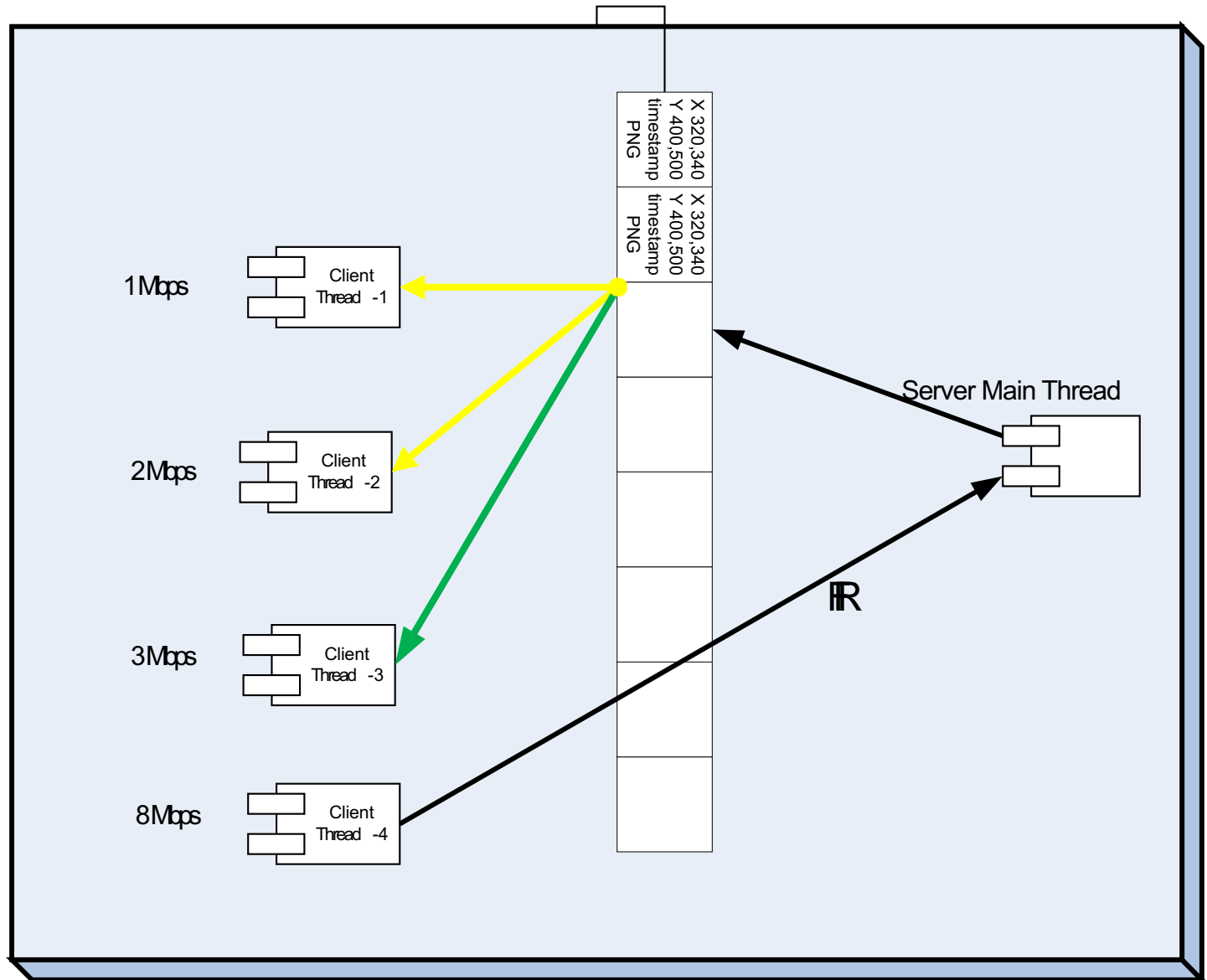


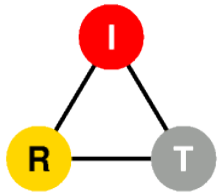
Different Client Bandwidths/Speeds



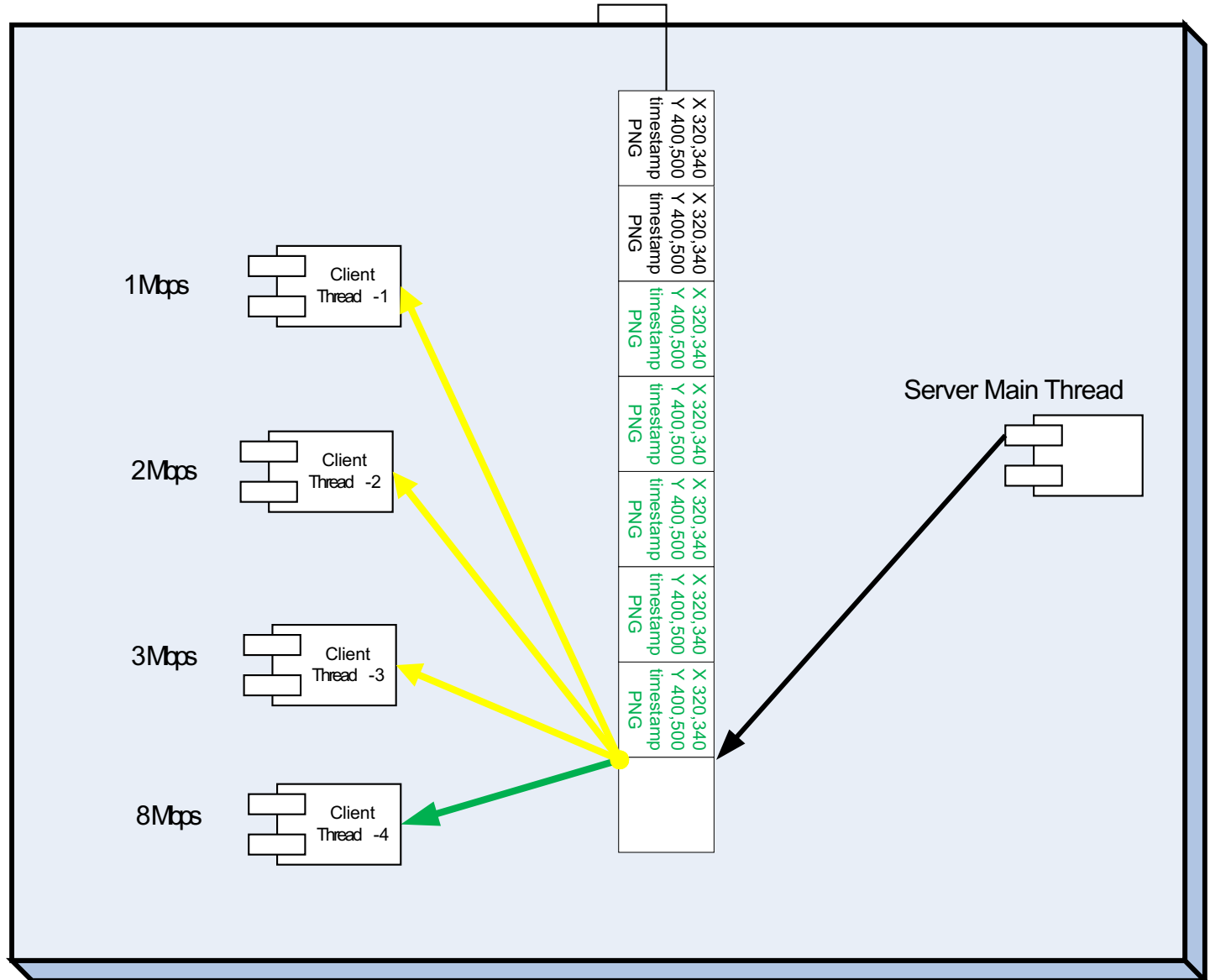


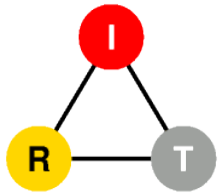
Different Client Bandwidths/Speeds



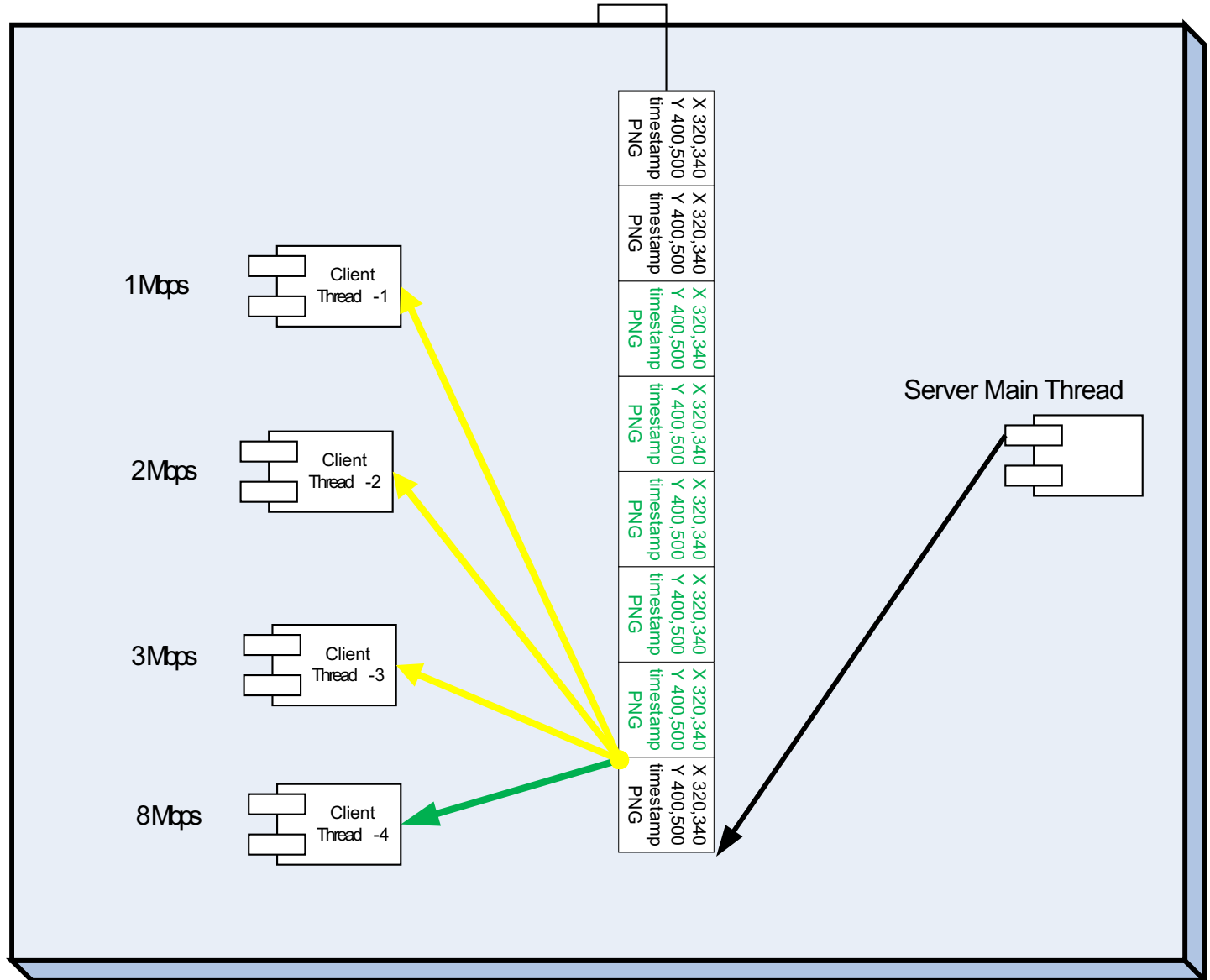


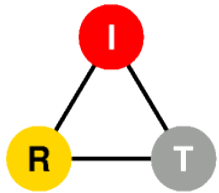
Different Client Bandwidths/Speeds



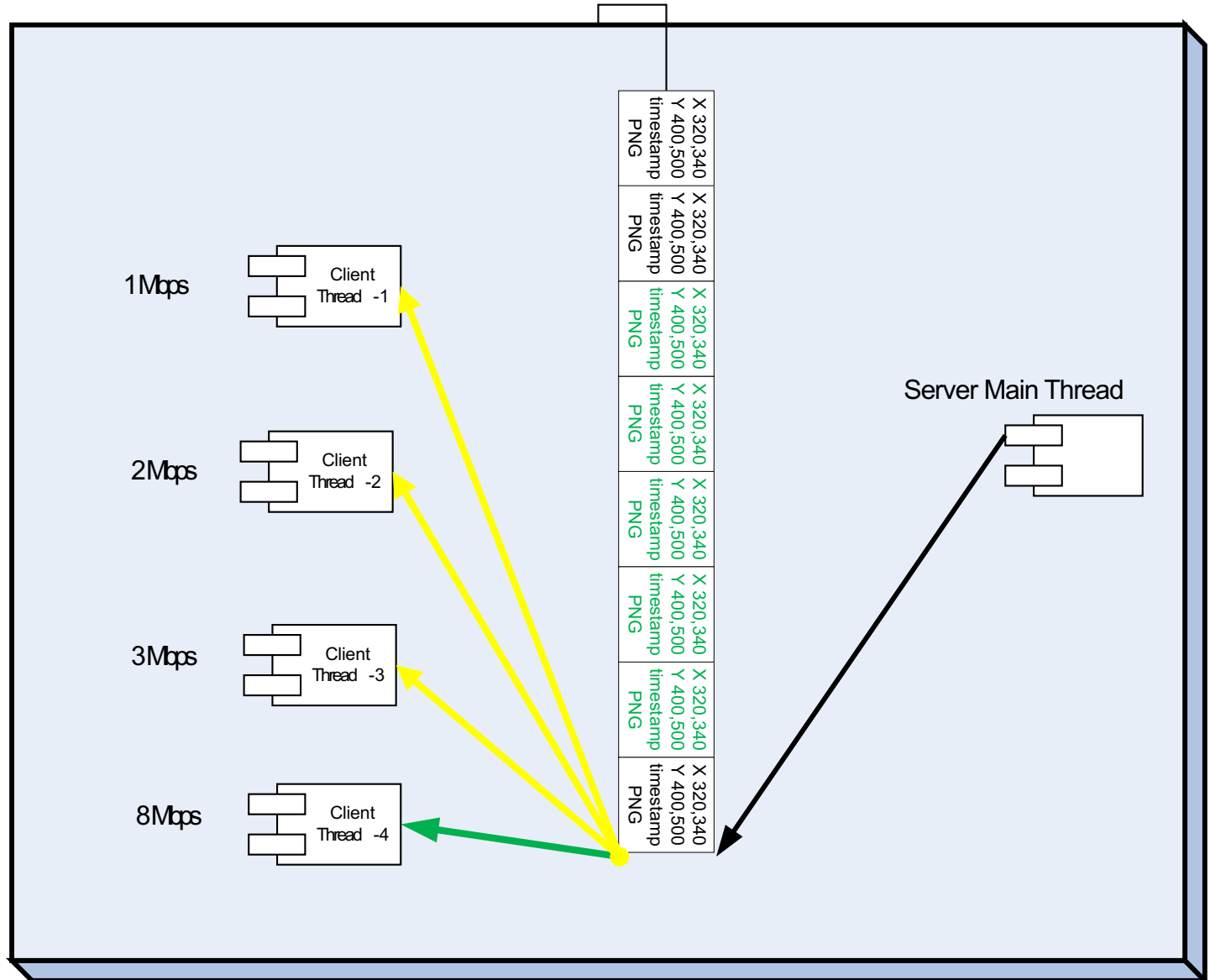


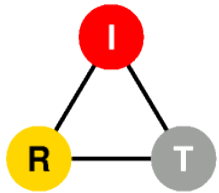
Different Client Bandwidths/Speeds



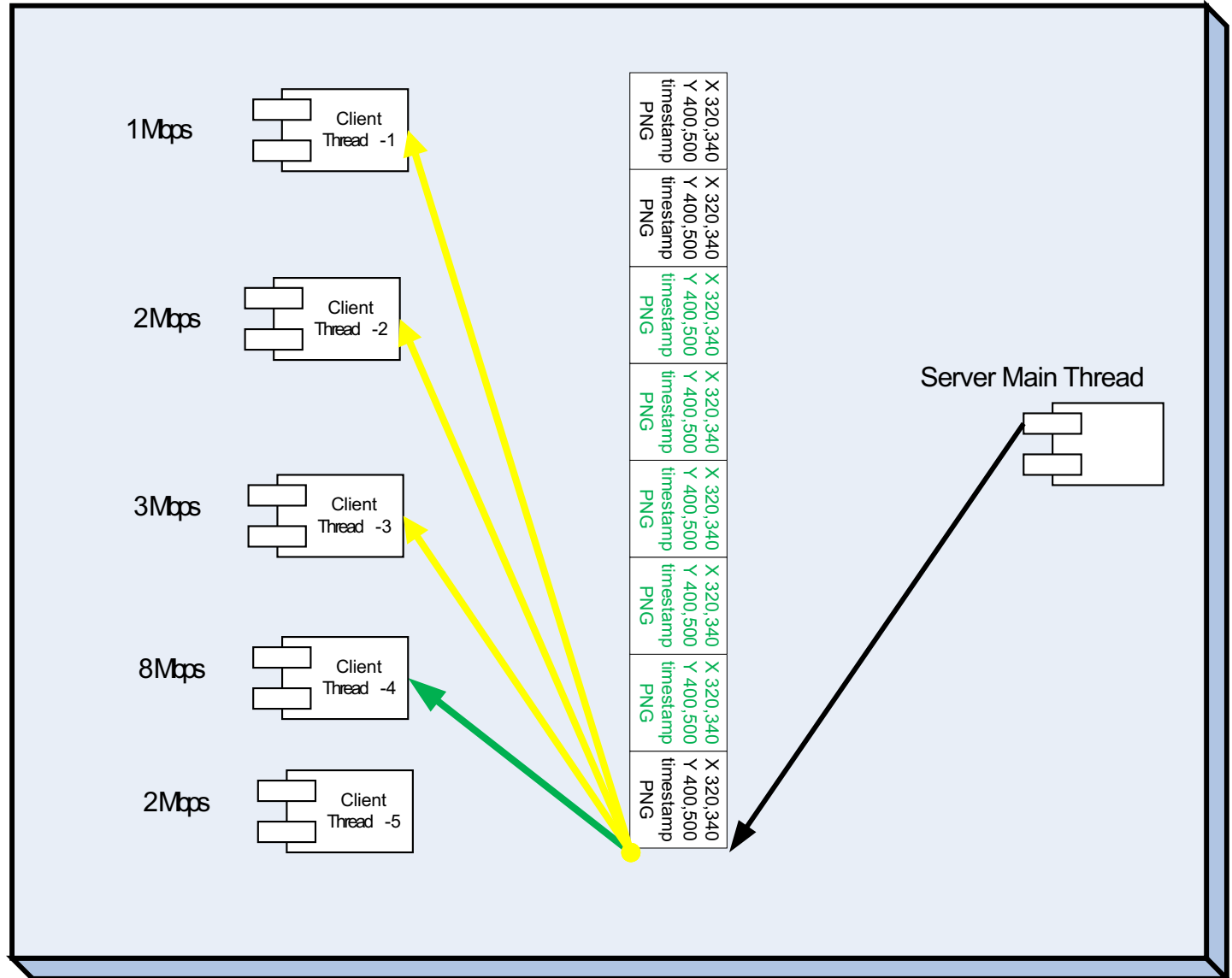


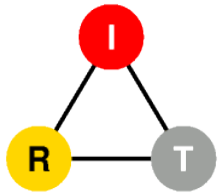
Different Client Bandwidths/Speeds



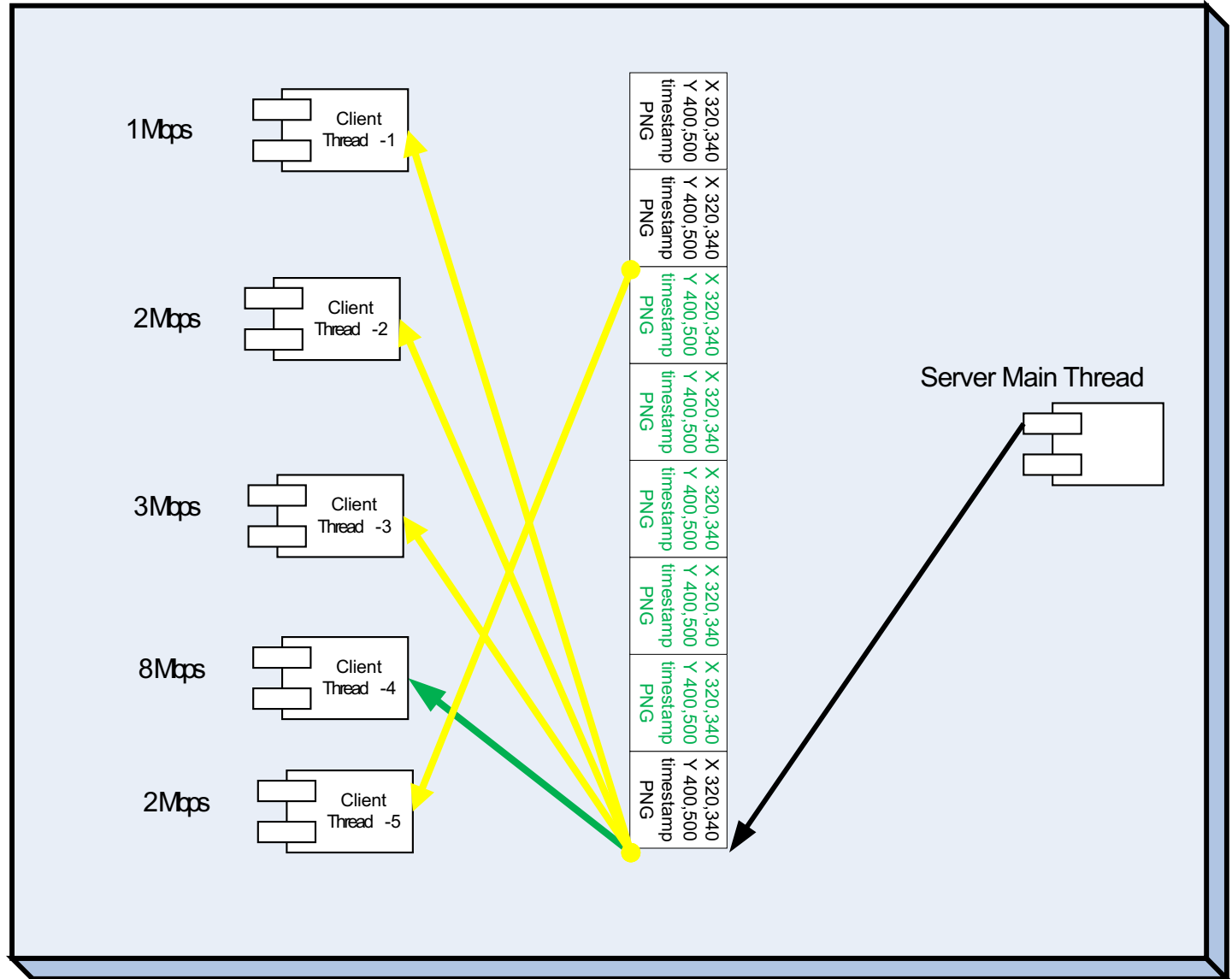


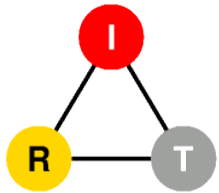
Different Client Bandwidths/Speeds





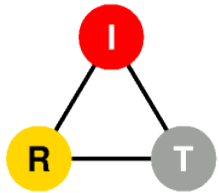
Different Client Bandwidths/Speeds





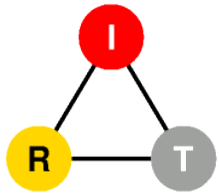
Challenges

- Different client bandwidths/speeds
- Late Joiner
- **The effects of packet loss**
- Reliable multicast



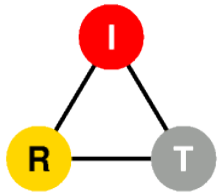
The effects of Packet Loss

- This problem applies to
 - Multicast
 - UDP
- The PNG images can be large
 - Regular desktop can be ~900KB
 - ~600 Ethernet packets
 - One packet loss wastes all PNG image

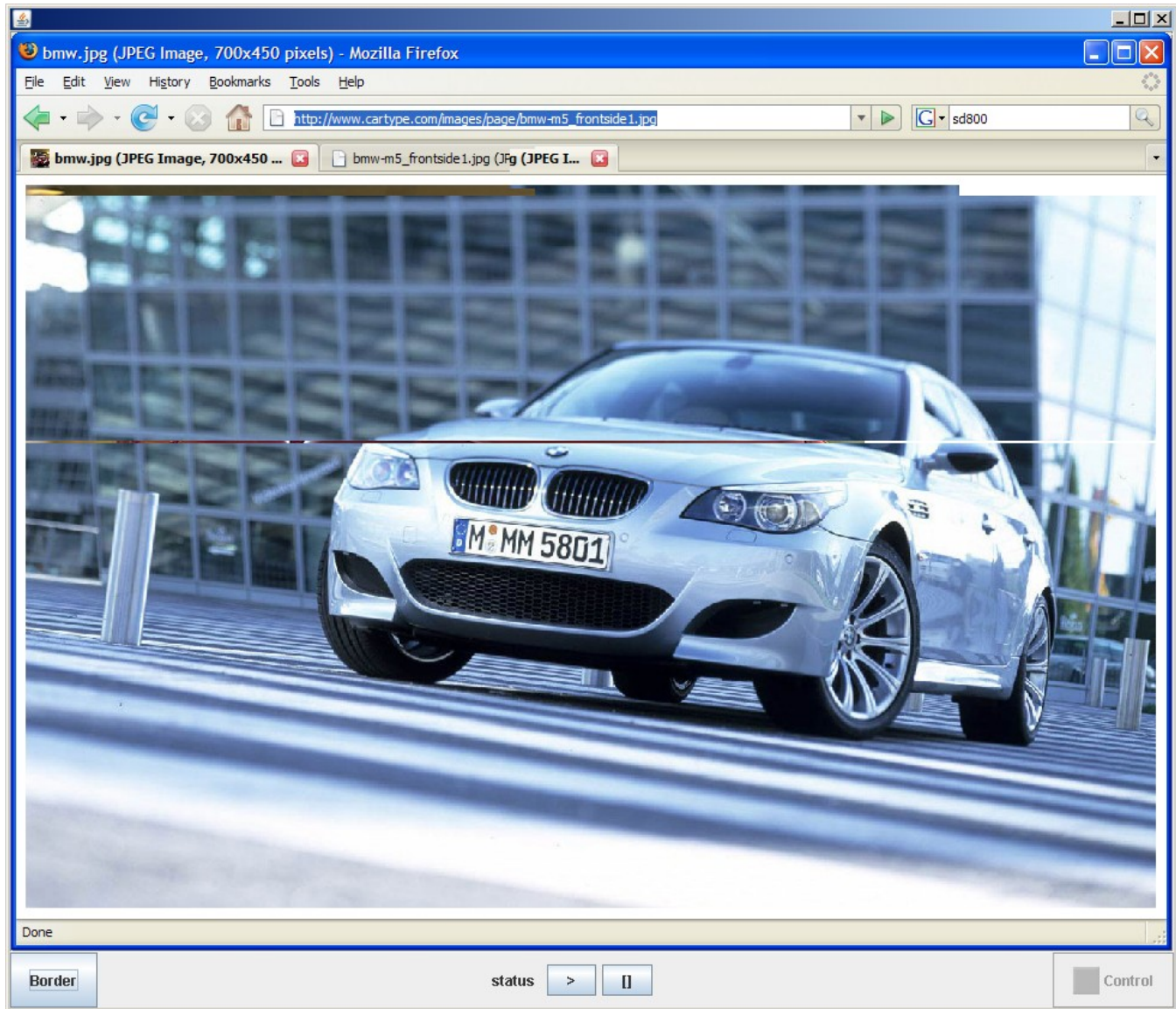


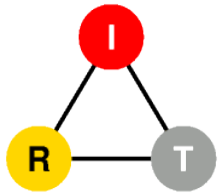
The effects of Packet Loss

- Solution
 - Small PNG images
 - Around ~1500 bytes
 - Consist of a few scanlines
 - Disadvantages
 - Increased CPU usage (client&server)
 - Lower compression ratio (%20 lower)
 - Advantages
 - One packet loss = no update for a few scanlines



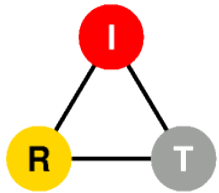
The effects of Packet Loss





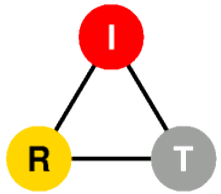
Challenges

- Different client bandwidths/speeds
- Late Joiner
- The effects of packet loss
- **Reliable multicast**

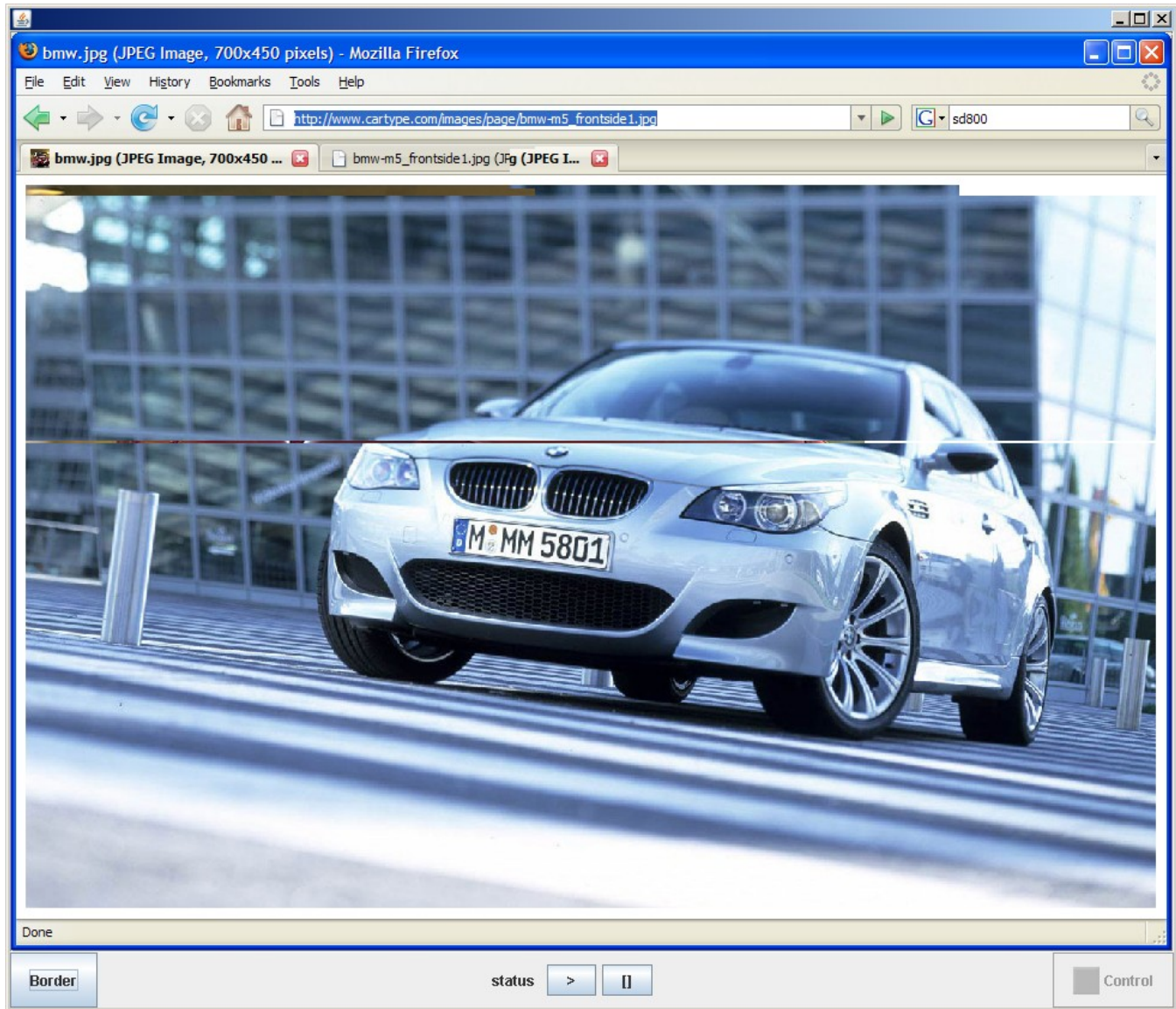


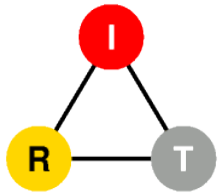
Reliable Multicast

- RTP Library stores last N rtp packets
- Clients send NACK for lost packets
- RTP Library resend the requested packets



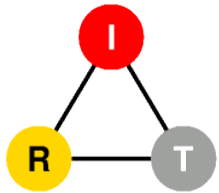
The effects of Packet Loss





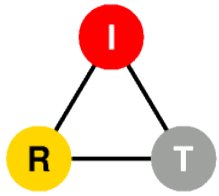
Overview

- Introduction
- Demo
- Architecture
- Challenges
- **Features**
- Conclusion



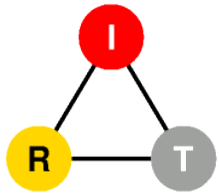
Recording

- Clients can record the whole/part session
- Anybody can play these files locally
- These files can be streamed to receivers via streaming server
- Streaming server supports multiple receivers
 - Also late joiners



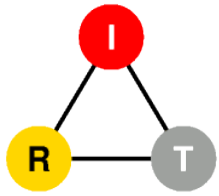
Listening Client

- Client waits for incoming connections
- It can display windows from multiple user
- Can be used for RGB cable replacement



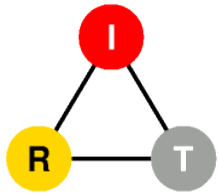
Overview

- Introduction
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- **Conclusion**



Conclusion

- Application sharing allows users to share a single application with multiple participants.
- Participants don't need the application.
- It is not specific to a single application.
- Extra features like recording is added.



Thanks

- Questions?